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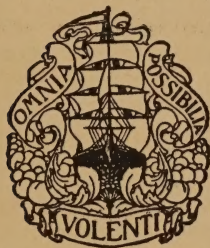
PHOTOGRAPHIC FACTS AND FORMULAS

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"AMERICAN PHOTOGRAPHY"

Author of "Practical Color Photography," etc.



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Foreword

The main idea kept in view in the compilation of this book has been to provide in condensed form working formulas and instructions for the various processes of photography. There must necessarily be errors of omission and commission, and the publishers will be grateful to any reader who, consulting its pages and failing to find what he requires, will at once communicate with them, in order that the omissions may be remedied in future editions. Forms for this purpose will be found at the end of the book.

The formulas given have not been selected in haphazard fashion but, as far as possible, only from creditable sources.

Certain valuable information, received after the body of the book was made up into pages, will be found in the Appendix at page 376.

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Studio and Workroom

WEIGHTS AND MEASURES.—It will be noted that formulas in this work are usually given both in metric and duodecimal (or British and U. S.) weights and measures. The metric weights and measures are not the *exact* equivalents of those in the other systems; but the *ratio* of the ingredients in *each column* is the same. Readers must therefore rigidly adhere to one or the other system, and not weigh out solids in grammes and measure liquids by ounces or a hopeless muddle will result. In all cases the conversion has been made on the assumption that photographic solutions are measured and not weighed out and, therefore, the ratios are based on a uniform bulk of 16 oz. or 7680 minims. In many cases fractional parts have been omitted or rounded off to the nearest practical quantity. In all cases, too, the quantities, 1000 ccm or 16 oz., mean that these should be the total bulk of the solution when made, unless otherwise stated. Therefore, it is advisable to dissolve the dry ingredients in some of the solvent and then make up to the given bulk.

BACKGROUNDS.—Cloth is the best material, and can generally be obtained up to 96 inches in width. Calico, bleached or unbleached, can be obtained up to 72 inches wide; brown felt paper up to 60 inches. Small pieces of cardboard, about $\frac{1}{2}$ inch square, are required. Lay the stretcher or frame flat on the floor, and get a friend to hold the right-hand bottom corner of the material down to the corresponding corner of the frame, stretch the material quite taut, and nail down the top left-hand corner to the edge of the frame. Drive the tack or nail through a piece of cardboard and the material at

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both corners. Then deal with the other corners in the same way. Then tack the center of the top and bottom edges, then the sides, pulling the material taut before putting in each nail. The result should be without any wrinkles. It must then be sized. For this rub one part of starch into a cream with three parts of water, and boil until a clear solution is formed. Apply this with a stiff brush to the material, and stand the frame on end to dry. To make the paint, use:

Whiting	24 parts
Powdered glue	8 parts
Treacle (molasses)	12 parts
Water	160 parts

Soak the glue in the water for some time, add the treacle and melt with heat, and stir in the whiting until a smooth cream is obtained. Divide into three parts. For colours, obtain the following dry water colour pigments: ivory black 2 parts, ultramarine 1 part, red ochre 1 part. Mix the three pigments together and divide into six equal parts; to one third of the glue solution add one part of the pigment, to another third of the glue add 2 parts of the pigment, and the remainder of the powder to the rest of the glue: this will give three distempers of different shades. Commercial distemper powders, such as kalsomine, may be used.

Alternatively, dry canvas may be tightly stretched on a wooden frame, then well wetted, a mixture of dextrine and colour sifted over the surface from a fine sieve, and the surface then worked over with a stiff brush. The colours used may be as above or any powder colour used for house decoration. The colours dry much lighter. For grey and black backgrounds, double size, which is used by paper-hangers, may be melted in a saucepan, slightly thinned down, and drop black and whiting, previously mixed to the required tint, added. Two coats should be given with a stiff brush, the

second being applied with the brush strokes in opposite direction to the first.

PHOTOGRAPHING MACHINERY.—Bright parts may be dulled by painting over with a thin cream of white lead and turpentine, darkened by the admixture of lampblack to give a grey. Frequently, dabbing the surfaces with a lump of putty will be sufficient.

MEMORIAL STONES AND BRASSES.—These often present considerable trouble, but if the surfaces of the stones are swept clean and strong side lighting used, the lettering and carvings will be thrown up into better relief. Wetting the stone frequently brings out indistinct lettering. In the case of brasses, rubbing with whiting, avoiding any deposit in the letters, is useful, as is also side lighting. Rubbings, obtained by placing a sheet of paper over the brasses and rubbing with a soft pencil or charcoal, may also be used.

SILVERWARE.—Hollow ware may be filled with ice or very cold water; then in a warm damp room the outer surface will become dewed. Dabbing the surface with putty will also kill all reflections. Or the object may be placed inside a tunnel of tissue paper, so that the only light reaching it has to pass through the paper.

GLASSWARE.—This may be treated like silver, or hollow vessels may be filled with a non-actinic solution.

COINS.—These may be smoked with burning magnesium ribbon, which leaves a delicate white film on their surfaces. Side lighting is preferable, so as to throw the figures, etc., into relief. An impression may be taken in fine plaster of Paris, and this photographed. Or the coins may be placed on a fine white calendered card, slightly dampened, with a backing of blotting or other soft paper, and passed through a copying or other press. This gives an intaglio of the coin, which, if lighted with a strong light from the bottom of the

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design, will when viewed in the usual manner give the impression of the relief of the original.

OBJECTS UNDER GLASS.—If it is desired to show the glass cover, give about one fourth of the whole exposure to the object with the glass in position; then remove the glass, and complete the exposure.

TO BLACKEN WOOD.—Use:

Borax	62.5 g	1 oz.
Glycerine	62.5 ccm	1 oz.
Shellac	125 g	2 oz.
Water	1000 ccm	16 oz.

Boil until completely dissolved and add water to make up the original bulk, then add nigrosine WS, 125 g or 2 oz., stir until thoroughly dissolved, and paint the wood two or three times. This is not as satisfactory as the following, in which the aniline black is chemically formed in the wood:

Cupric chloride	70 g	538 gr.
Potassium bichromate	70 g	538 gr.
Hot water	1000 ccm	16 oz.

The wood should be freed from grease, then painted with this solution and allowed to dry well, then painted with:

Aniline hydrochloride	140 g	2¼ oz.
Water	1000 ccm	16 oz.

Allow to dry, wipe off any yellow powder that forms, and repaint with these solutions until black enough. As a rule, two coats are sufficient, as the colour deepens in a day or two. Then rub well with boiled linseed oil and leave to dry.

TO BLACKEN BRASS.—Use:

Copper nitrate	208 g	200 gr.
Water	500 ccm	1 oz.

Dissolve and add the following solution:

Silver nitrate	208 g	200 gr.
Water	500 ccm	1 oz.

Clean the metal thoroughly, immerse in the mixture, and then heat; repeat if necessary. Or the following may be used:

Copper carbonate	50 g	384 gr.
Ammonia	25 ccm	192 min.
Water	1000 ccm	16 oz.

Clean the metal and immerse until black, then wipe dry and lacquer. This attacks soft solder. Solution of antimony (butter of antimony), brushed on, gives bronze colours. It has been stated that boiling the metal in a solution of potassium sulphide (liver of sulphur) until sufficiently black, then rinsing, drying and smearing a little oil over it, gives better results than the above silver method.

FIREPROOFING FABRICS.—Soak in:

Alum	80 g	8 oz.
Ammonium carbonate	25 g	2½ oz.
Boric acid	15 g	1½ oz.
Borax	17.5 g	1¾ oz.
Water	1000 ccm	100 oz.

Or:

Boric acid	11 g	200 gr.
Ammonium phosphate	100 g	4 oz.
Water	1000 ccm	40 oz.

Or:

Borax	150 g	12 oz.
Magnesium sulphate	112.5 g	9 oz.
Water	1000 ccm	80 oz.
Starch	25 g	2 oz.

Boil the starch with the water and add the salts. Immerse the fabric until thoroughly soaked, then dry and iron. Or a strong solution of aluminum acetate, sp. gr. 1.050, diluted with 40 times its volume of water, may be used. The material should be immersed for 24 hours and then dried in the shade.

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FLEXIBLE LANTERN SCREEN.—Take:

Glycerine	16 parts
White glue	16 parts
Zinc oxide	32 parts
Hot water	10 parts

All are to be weighed. Dissolve the glue in the hot water and add the zinc oxide, ground up with the glycerine. Apply hot to the screen. A screen 10 feet square requires about 160 ounces.

TO BLACKEN ALUMINUM.—Clean perfectly free from grease by washing in soda solution, wash well, and immerse in:

Ferrous sulphate	1 part
Arsenious acid	1 part
Hydrochloric acid	12 parts
Water	12 parts

When the colour is deep enough, dry with fine sawdust, and lacquer. This solution is intensely poisonous.

BLACK FOR CAMERAS.—This may be used for wood or leather, inside or out:

Nigrosine, spirit soluble	2.5 g	37 gr.
Bismarck brown	0.65 g	10 gr.
Denatured alcohol or methyiated spirit	3.0 ccm	50 min.
Aniline	29 ccm	1 oz.

Heat the dyes with the alcohol until dissolved, and then add the aniline; apply with a brush and dry before the fire or in the sun. Or, for a dead matt varnish, lampblack may be rubbed up with gold size or shellac varnish, using as little of the liquid as possible; then thin down with turpentine.

INK FOR BOTTLES.—The following formula gives a water-proof ink, and either black or white ink can be made by using lampblack or zinc white.

Copal, powdered	12 g	90 gr.
Oil of lavender	1000 ccm	16 oz.
Dissolve by heat and stir in, for black:		
Lampblack	1.2 g	9 gr.
Indigo	0.5 g	4 gr.
Or, for white:		
Zinc white	1.5 g	11 gr.
Apply with a fine brush.		

MATTING GLASS.—Dissolve by heat:

Sodium or potassium fluoride	4 g	20 gr.
Gelatine	4 g	20 gr.
Water	1000 ccm	1 oz.

Coat on the glass and allow to set well and dry, then immerse in a 6 per cent solution of hydrochloric acid for 30 to 60 seconds, and dry without washing. The gelatine can be dissolved off with hot water and a fine matt surface is obtained.

Or the following may be used:

A. Sodium fluoride	60 g	60 gr.
Potassium sulphate	12 g	12 gr.
Water	500 ccm	1 oz.
B. Zinc chloride	14 g	14 gr.
Hydrochloric acid	65 ccm	65 min.
Water	500 ccm	1 oz.

Mix in equal quantities just before use and apply with a quill pen or fine brush. In about 30 minutes a fine matt surface is obtained. Another plan, which is even more convenient, is to paint a square or rectangle with the above solution, when the whole surface will be matted. Titles may easily be written on the surface with a soft lead pencil, and can be easily removed at any time with rubber or soap and water.

SUBSTITUTES FOR GROUND GLASS.—Expose a dry plate to the light of a match at a distance of 3 feet, then develop until uniformly grey, fix and wash. Immerse the plate in a solu-

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tion of iodine in potassium iodide, or a few drops of tincture of iodine in water, until the grey fog turns yellow; then rinse, immerse in weak ammonia water until it turns white, wash and dry. The longer the plate is developed in the first place, the more pronounced becomes the mattness. As a rule, this gives a surface that is only useful with a magnifier, the grain being too fine for ordinary visual work. Or the following may be used:

Rice starch	20 parts
Water glass	100 parts
Water	200 parts

The water glass is the ordinary commercial solution of sodium silicate of 1.3 sp. gr. Mix the above by first rubbing the starch up with the water and then adding the silicate. Level the glass and pour enough of the solution on to cover it, allow to dry, then coat with celluloid varnish.

TO CLEAN GLASS.—Immerse the glass in the following:

Potassium bichromate	50 g	1 oz.
Sulphuric acid	25 ccm	½ oz.
Water	1000 ccm	20 oz.

Immerse the glass and scrub with an old toothbrush or mop made by tying some rags on a stick, turning the glasses over with a stick, as the solution bites the fingers. Rinse in cold water, then in hot water and dry. Or make a thin cream of:

Tripoli	500 g	8 oz.
Denatured alcohol or methyiated spirit	500 ccm	8 oz.
Ammonia	500 ccm	8 oz.

Rub well with a swab of cloth and polish with a clean cloth, finishing with filter paper.

CEMENTS.—Melt rubber and shellac in equal parts on a sand bath and apply to the warm glass or metal. This is useful for cementing glass to glass, or glass to metal. Or

glycerine and finely powdered litharge may be worked into a thick paste; the broken edges should be painted with glycerine, then the paste applied, and the articles bound together with string and left for a day or two. Or zinc oxide should be worked into a stiff paste with a 15 per cent solution of zinc chloride. Or:

Sulphur flowers	72 parts
Pale resin	40 parts
Shellac	10 parts
Mastic	20 parts
Crude lac	20 parts
Barium sulphate	60 parts

Melt the gums by heat and add the sulphur, stir well and then add the baryta. This must be melted each time before use.

DIAMOND CEMENT.—Dissolve gelatine to saturation in glacial acetic acid. This must be melted on a water bath before use.

DAMP-PROOF GLUE.—Cover some good glue with water and allow to soak for 12 hours, drain off the water, melt the glue by heat, and add one-fourth its volume of linseed oil.

MARINE GLUE.—Dissolve india rubber shreds in benzole 1 part, shellac 2 parts; or ordinary cycle tyre cement may be used, one-fourth its volume of shellac added, and melted by heat. The vapour of this is very inflammable.

LIQUID GLUE.—This should not be used for mounting photographs:

Fine glue	800 g	8 oz.
Water	1000 ccm	10 oz.

Allow to soak for 24 hours, then melt by heat, and add:

Nitric acid, strong	175 ccm	1¾ oz.
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SILVERING GLASS.—*Brashear's Process modified, as used at the Royal Observatory, Greenwich, England.* The follow-

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ing solutions are required: A. 10 per cent silver nitrate solution; B. 25 per cent ammonia solution; C. 10 per cent caustic potash solution; D. reducing solution as follows:

Sugar	90 g	690 gr.
Nitric acid	4 ccm	30 min.
Alcohol	175 ccm	2 oz., 380 min.
Water	1000 ccm	16 oz.

To make this, dissolve the sugar and acid in the water, boil for 15 minutes, cool down, and add the alcohol. The longer this solution has been made, the better it works. The actual silvering bath is made up as follows:

A solution	20 ccm	340 min.
B solution (more or less)	10 ccm	170 min.
C solution	10 ccm	170 min.
D solution	5 ccm	85 min.
Distilled water	100 ccm	3 oz., 250 min.

To prepare the bath for about 700 square inches of glass surface, take 1200 ccm (42 oz., 112 min.) of A, and add B until the solution nearly clears up, which will take about 500 ccm (17 oz., 287 min.); then add C 600 ccm (21 oz., 56 min.). The mixture will again become thick; then add cautiously more B until the solution clears. It should now be a brown colour but transparent. Then add:

Distilled water	6000 ccm	211 oz., 84 min.
D solution	300 ccm	10 oz., 268 min.

The temperature should be from 18° to 21° C. (65° to 70° F.). With lower temperatures the D solution must be slightly increased. Too low temperatures give too thin films, while with too high temperatures the silver film is too soft. The glass should be covered with water, and, if the solutions are mixed beforehand, the water should be poured off and the silvering liquid at once applied; but good results are obtained by pouring off the water, pouring on the D solution,

rocking the dish, and then adding the silver-potash mixtures. The action begins at once, and in 2 or 3 minutes a light swab of absorbent cotton should be lightly drawn over the surface so as to prevent the heavy sediment from settling down. As the cotton becomes dirty, it should be thrown away and fresh used. When to stop the action depends entirely upon experience; if too soon, the deposit is thin, and if too prolonged, it is thick and requires much polishing. Wash with distilled water, lightly swab with cotton, and allow to dry in a vertical position for at least an hour. Polishers are most satisfactorily made of the best chamois leather stretched over a ball of cotton. Two polishers are necessary. First go over the whole surface with a plain rubber with light circular strokes, dusting occasionally. Then rub a little rouge into the other pad, and polish in the same way.

It has been stated that celluloid can be silvered with the above solution; or the celluloid may be immersed in the sugar solution and then the others added in succession. For the above process the old fashioned sugar candy is the best form of sugar to use; if this is not procurable, the best cane sugar must be used.

R. E. Crowther gave a modification of this process in which caustic soda is used and which seems not to be so dependent on absolute purity of the chemicals. To make 100 ccm (3 oz., 250 min.) of solution, the following are required: I. 10 per cent solution of silver nitrate in distilled water; II. 7.25 per cent solution of caustic soda in distilled water; III. 28 to 30 per cent ammonia solution (strongest ammonia water); IV. Reducing solution—equal volumes of A and B, made as follows:

A. Sugar, lump or white crystal	9 g	150 gr.
Distilled water	50 ccm	845 min.
Nitric acid, c. p.	0.4 ccm	6 min.

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Alcohol	17 ccm	285 min.
Distilled water to	100 ccm	3 oz., 250 min.
B. Sugar	10 g	165 gr.
Distilled water	50 ccm	845 min.
Tartaric acid, cryst.	1 g	15.4 gr.

Boil for 5 minutes, cool and add:

Alcohol	18 ccm	304 min.
Distilled water to	100 ccm	3 oz., 250 min.

For every 100 ccm silvering solution take: 11 ccm solution I. (186 min.), remove 4 ccm (68 min.), and dilute with 15 ccm (250 min.) distilled water; add to the 7 ccm, while shaking, ammonia III., until just clear; then, while shaking, add 10 ccm (169 min.) solution II., and again, while shaking, add enough ammonia to just redissolve the precipitate. Finally, add the diluted 4 ccm of solution I., obtaining a sherry-coloured, opalescent liquid. Filter and dilute to 78 ccm (2 oz., 358 min.). Mix 11 ccm (186 min.) of IV. with 11 ccm distilled water, add to the sherry-coloured silver solution, and pour immediately on the glass, which should be from 3° to 6° C. (5° to 10° F.) warmer than the solution. Rock vigorously, and silver for two and a half times the time observed from pouring on the mixed solutions until deposition commences. Rinse twice in distilled water, swab under a tap, blot off the surface water, allow to dry half an hour in a warm place, and polish off the slight bloom.

The Rochelle Salts Process.—Two solutions are required for this:

A. Silver nitrate	10 g	77 gr.
Distilled water	1000 ccm	16 oz.
B. Silver nitrate	2 g	15.4 gr.
Rochelle salts	1.66 g	12.5 gr.
Distilled water	1000 ccm	16 oz.

In making this solution the water should be brought to a boil,

and first the silver and then the Rochelle salts added, both being dissolved in as small a quantity of boiling distilled water as possible. Boiling should be continued for about 25 minutes, until a grey powder has collected at the bottom of the flask. The liquid should then be at once filtered until quite clear, and it may be necessary to repeat this three or four times. The longer the boiling the more rapid the deposition of the silver, and the more uniform it will be. Perfectly prepared solutions will keep for about a month. Equal volumes of the two solutions are mixed just before use.

The Formaldehyde Process (Lumière).—Clean the glass thoroughly with nitric acid, and wash well with distilled water. Pour on the surface a 25 per cent solution of alcohol and leave for a few minutes. Prepare the following solution, which must not be made until required for use:

Formaldehyde, 40% solution	24 drops	24 drops
Alcohol, 90%	24 ccm	407 min.
Distilled water	24 ccm	407 min.
Silver solution	48 ccm	812 min.

This is sufficient for 1000 qcm (155 sq. in.), and the temperature should be from 16° to 20° C. (60° to 68° F.). The silver solution is prepared as follows:

Silver nitrate	10 g	77 gr.
Distilled water	100 ccm	2 oz.

Add solution of ammonia drop by drop until the brown precipitate first formed is redissolved; but extreme care must be taken not to add too much ammonia. Then add:

Silver nitrate	2 g	15.4 gr.
Distilled water	100 ccm	2 oz.

Then add sufficient water to make the total bulk 1000 ccm (16 oz.), and filter several times until quite clear. The glass should be drained from the alcohol bath and immediately covered with the silvering solution. The deposition begins in

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about 90 seconds and will be complete in about 2 minutes. During the silvering, the bath should be gently rocked to prevent striæ. As soon as the liquid begins to become cloudy or show spicules of silver, it should be poured off and a second quantity of solution applied. Several coatings may be thus applied until the desired thickness is obtained. At the close of the operation the surface has a slightly reddish-brown appearance. It should be washed with successive lots of distilled water and dried, standing it on white blotting paper. When the film is perfectly dry, it can be polished with a soft chamois, enclosing a pad of absorbent cotton and rouge; the rouge used for gold is the best. The alcohol is used to prevent the formation of a precipitate in the solution, and, if this forms, too much formaldehyde has been used. If too little formaldehyde be used, the film has a pronounced reddish-brown colour and is punctuated with numerous pin-holes. In all cases, the formaldehyde must only be added just before applying the mixture to the glass. If too high a temperature be used, the deposit forms too rapidly and becomes powdery. For small mirrors, the glass may be placed in a dish of porcelain or glass, and the alcohol bath may be omitted. If, instead of using the silvered surface as the mirror, the glass side is used, then the silver coat should be covered with:

Gum dammar	10 g	77 gr.
Bitumen of Judea (asphalt)	100 g	770 gr.
Red ochre	200 g	3 1/5 oz.
Benzole	1000 ccm	16 oz.

The ammoniacal solutions of silver are dangerous to keep in stock, as they may form fulminating silver which is explosive.

LINE DRAWINGS FROM PRINTS.—Waterproof drawing ink should be used in drawing over any desired part of the print; then immerse it in:

Iodine	0.5 g	3.84 gr.
Potassium cyanide	0.03 g	0.25 gr.
Water	1000 ccm	16 oz.

Rub the cyanide up with the iodine, add first a very little water, and then make up to bulk. Or the following may be used:

Thiocarbamide	15.5 g	119 gr.
Nitric acid	15.5 ccm	119 min.
Water	1000 ccm	16 oz.

Or:

Potassium bichromate	8 g	62 gr.
Sulphuric acid	12 ccm	90 min.
Water	1000 ccm	16 oz.

Then wash well.

NEGATIVES DIRECT.—This method may be used for direct or enlarged prints on paper or plates. The image should be developed with:

Amidol	6.25 g	45 gr.
Sodium sulphite, dry	15.6 g	120 gr.
Ammonium bromide	4.75 g	36 gr.
Potassium metabisulphite	2 g	15 gr.
Water	1000 ccm	16 oz.

Development should be stopped when the image is seen through at the back of the plate. Wash for 5 minutes, back with a piece of wet black paper, and expose to daylight for 30 seconds or to 6 inches of magnesium ribbon held one foot from the plate. Bleach in:

Potassium bichromate	29.3 g	225 gr.
Nitric acid	12 ccm	90 min.
Water	1000 ccm	16 oz.

Then immerse in:

Sodium sulphite, dry	95 g	1½ oz.
Potassium metabisulphite	6.25 g	45 gr.

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Water	1000 ccm	16 oz.
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This clears the bichromate stain; after the plate has been well washed, develop in the developer given above without the bromide.

LIQUID SAFELIGHTS.—Sometimes cells filled with liquid are used in front of the light, but they present no particular advantage. The following have been recommended:

Deep orange (Farmer): Potassium bichromate 6 per cent solution in $\frac{3}{8}$ inch thickness. This is only suitable for ordinary plates.

Or (Davenport):

Mandarin orange	20 g	154 gr.
Water	1000 ccm	16 oz.

Or (Wordsley):

Eosine	0.13 g	0.1 gr.
Metanil yellow	3.2 g	25 gr.
Water	1000 ccm	16 oz.

Or, for a darker filter:

Eosine	0.4 g	3 gr.
Metanil yellow	2.6 g	20 gr.
Water	1000 ccm	16 oz.

Or (Davenport):

New coccin	2 g	15.4 gr.
Water	1000 ccm	16 oz.

For deep red in 1 inch thickness:

Tartrazine	0.5 g	3.8 gr.
Violet Dahlia BO	0.2 g	1.5 gr.
Water	1000 ccm	16 oz.

Or:

Naphthol yellow S	1 g	7.7 gr.
Violet Dahlia BO	0.18 g	1.38 gr.
Water	1000 ccm	16 oz.

Liquid green filter :

Acid green	0.6 g	4.6 gr.
Naphthol green	0.6 g	4.6 gr.
Tartrazine	1.5 g	11.5 gr.
Water	1000 ccm	16 oz.

The water in the above formulas is apt to evaporate, and this trouble may be overcome by using glycerine instead.

Tartrazine 0.05 per cent solution absorbs to wave-length 510. Potassium bichromate 10 per cent solution absorbs to 550. The same solution plus 0.1 per cent of fuchsine to 620; with 0.2 of fuchsine to 630; with 0.5 per cent fuchsine to 635; with 0.2 per cent acid violet to 645. Tartrazine 0.05 per cent solution plus 0.02 per cent methyl violet to 660. Thickness of liquid in all cases 10 cm. For a green light with a liquid thickness of $2\frac{1}{2}$ cm, use :

Blueish acid green	0.625 g	4.8 gr.
Naphthol green	0.075 g	0.576 gr.
Tartrazine	0.045 g	0.35 gr.
Water	1000 ccm	16 oz.

In course of time, the water evaporates from the heat of the lamp. This can be obviated by using glycerine as the solvent instead of water.

GLASS SAFELIGHTS.—Coloured glasses, or glass coated with gelatine stained with dyes, are best for illumination of the darkroom. The most satisfactory method of making the latter is to add a definite quantity of dye to a given quantity of gelatine solution and allow a definite quantity per area. Soft gelatine is the most suitable, and either a 6 or 8 per cent solution should be made. Weigh out the gelatine and cover with water, stir for about 5 minutes and pour the water off, and repeat this three times; finally, drain off as much water as possible, melt the gelatine in a water bath, and add enough water to make up to bulk. The temperature

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should be about 60° C. (140° F.), and the dye added, preferably, in solution. The glass should be levelled, the necessary quantity of the dyed gelatine coated on it, allowed to set and dried. Yellow screens, suitable for bromide papers and lantern slide work:

Tartrazine	8 g	62 gr.
Gelatine solution, 8%	1000 ccm	16 oz.

Allow 7 to 10 ccm to 100 qcm, or 750 to 1000 minims per 100 sq. in. Two such glasses should be bound up together.

Orange:

Rose Bengal	3 g	23 gr.
Gelatine solution, 8%	1000 ccm	16 oz.

Use the same quantity as above, and bind one of these red screens with one of the yellow tartrazine ones.

Bright red:

Xylene red	8 g	62 gr.
Gelatine solution, 8%	1000 ccm	16 oz.

Use the same quantity and bind with one of the tartrazine screens.

Deeper red:

Crystal violet, 4% sol.	8 ccm	62 min.
Gelatine, 8%	1000 ccm	16 oz.

Use as above with a tartrazine screen.

Bright red (Hübl):

Fast red	5 g	38½ gr.
Tartrazine	5 g	38½ gr.
Gelatine, 8% sol.	1000 ccm	16 oz.

Allow 7 ccm per 100 qcm, or 750 minims per 100 sq. in. This cuts out all light to 600, and is safe for all ordinary plates.

Deep red (Hübl):

Crystal violet	1.65 g	12.7 gr.
Cupric sulphate	8.25 g	63 gr.

Glacial acetic acid	16 drops	8 drops
Gelatine, 6% sol.	1000 ccm	16 oz.

Allow the same quantity as above, and bind up with one of the bright red screens. Or:

Tartrazine	7.5 g	57½ gr.
Crystal violet	15.5 g	120 gr.
Cupric sulphate	77.5 g	595 gr.
Glacial acetic acid	15 drops	8 drops
Gelatine, 8% sol.	1000 ccm	16 oz.

Use the same quantity as above. This cuts out to 630 and is safe for orthochromatic plates.

GREEN SAFELIGHTS.—These are used for panchromatic plates, and are occasionally adopted instead of the red, for with a green light it is possible to see better than with a faint red. Hübl recommended a combination of filter blue with naphthol green, which is the only green dye that cuts out the extreme red. The blue was made into a stock solution of:

Filter blue	0.1 g	0.77 gr.
Water	1000 ccm	16 oz.
Ammonia	1 ccm	7.7 gr.

For the screen use:

Naphthol green	8 g	61 gr.
Blue solution as above	32 ccm	½ oz.
Gelatine, 8% sol.	1000 ccm	16 oz.

Allow 7 ccm per 100 qcm, or 750 minims per 100 sq. in.

Or (Löwy):

New Bordeaux R	3.25 g	25 gr.
Tartrazine	6 g	46 gr.
Light green S	9 g	69 gr.
Glycerine	50 ccm	384 min.
Gelatine, 8% sol.	1000 ccm	16 oz.

Allow about 10 ccm per 100 qcm, or 1000 minims per 100 sq. in.

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Old fixed-out dry plates, or negatives freed from their images by reduction, may also be used by soaking in the above dye solutions minus the gelatine, that is, using water instead of the gelatine solution, for half an hour, then rinsing and drying. Or soak one plate in 3 per cent solution of naphthol yellow, and another in 0.9 per cent solution of methyl violet for half an hour, rinse, dry and bind together. The following was suggested by Haberkorn:

Gelatine	60 g	460 gr.
Water	1000 ccm	16 oz.

Soak for 30 minutes, melt on water bath, and add:

Blueish acid green	15 g	115 gr.
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Then add:

Tartrazine	0.18 g	13.8 gr.
Naphthol green	0.4 g	3.1 gr.

Stir well and filter while hot. To every 100 qcm allow 7 ccm, or 750 minims per 100 sq. in. Bind two such screens together, and coat one with matt varnish, or use tissue paper between; a sheet of ground glass placed between the light and the screen absorbs some of the heat.

NON-ACTINIC PAPER.—Soak the paper in:

Tartrazine	10 g	77 gr.
Rhodamine	1 g	7.7 gr.
Water	500 ccm	8 oz.
Alcohol	500 ccm	8 oz.

The quantity of rhodamine may be increased at will, when a deeper coloured paper will be obtained. The above paper is safe for rapid ordinary plates. Translucent vegetable parchment paper was also suggested. This was to be immersed for 5 minutes in a warm 10 per cent solution of gelatine and dried, then stained up in one of the following baths:

- | | |
|----------------|-----------------------|
| A. Tartrazine | 2 per cent solution |
| B. Chrysoidine | 0.1 per cent solution |

- | | |
|------------------|-----------------------|
| C. Blue carmine | 1.0 per cent solution |
| D. Methyl violet | 0.1 per cent solution |

A gives a bright yellow paper, and one thickness is suitable for development papers. Two sheets of B and one of A are suitable for bromide papers and slow plates. Two of C and one of A are suitable for panchromatic plates, if not too bright a light be used; another A makes it safer. One of A and one of C may be used for ordinary and orthochromatic plates (Namias).

ALCOHOL.—In several formulas “alcohol” is recommended as an ingredient, although under the prohibition act it is impossible for the average person in the United States to obtain this in any legal manner. In some cases ordinary denatured alcohol may be used, but in others as, for instance, the colour-sensitising of plates, this is worse than useless because it has a very prejudicial effect on the emulsion. It is possible to obtain from chemical and bacteriological supply houses pure methyl alcohol under the names of Eagle methanol, or Columbian methanol or spirits, or methyl alcohol C. P., and these may be substituted in nearly every case.

Orthochromatic Photography

WAVE-LENGTHS OF THE PRINCIPAL FRAUNHOFER LINES.

Fraunhofer line	Wave-length	Colour
A	7594	
a	7186	Red
B	6867	
C	6563	Bright red
D ₁	5896	Yellow-orange
D ₂	5890	
E	5270	Green
b ₁	5184	
b ₂	5173	
b ₃	5169	
b ₄	5168	
F	4861	Bright blue
G	4308	Indigo blue
g	4227	
h	4101	
H ₁	3968	Violet
H ₂	3960	Violet
K	3934	Ultra-violet
L	3821-3816	Ultra-violet
M	3728	Ultra-violet
N	3581	Ultra-violet
O	3441	Ultra-violet
P	3361	Ultra-violet
Q	3287	Ultra-violet
R	3180	Ultra-violet
S	3100	Ultra-violet
T	3021	Ultra-violet
U	2948	Ultra-violet

The wave-lengths in the above table are those given by Rowland, and are usually employed, but for extreme accuracy in spectroscopic work corrections must be used. The unit of measurement is Angstrom's unit, one ten millionth of a millimeter or A. U. (called also tenth meter, t. m.), and only round numbers are given; thus, taking the red cadmium line, it would be called on the above plan 6438, while its correct measurement is 6438.4722. It is frequently the custom to employ other units, for instance, the millionth of a millimeter $m\mu$ is used, or the thousandth of a millimeter μ (pronounced mu). Thus the cadmium line may be expressed as: 6.4384722×10^{-5} cm, or 0.64384722 μ , or 643.84722 $m\mu$ or $m\mu$, or 6438.4722 A. U. or t. m. It is usual in photographic literature to use the abbreviated A. U., as 6438 or the still briefer designation 644. The Greek lambda or λ is used to designate the wave-length.

It is very frequent also to designate a colour or position in the spectrum by such a term as D $\frac{1}{2}$ C, which means half way between the lines D and C; this would mean, taking 5893 as the mean wave-length of the D lines, that the stated position would be half the distance or difference of wave-lengths, thus C 6563 — 5893 = 670, then 670 divided by 2 plus 5893 = 6228, the designated wave-length.

DISTRIBUTION OF COLOURS IN THE SPECTRUM.—Various tables of the distribution of the colours in the spectrum have been given, but the following compiled by Listing may be accepted as being typical:

Colour		Wave-length
	End	819
Deep red	Middle	768
	End	723
Red	Middle	683
	End	647

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Orange	Middle	614
	End	585
Yellow	Middle	559
	End	534
Green	Middle	512
	End	491
Cyan blue	Middle	473
	End	455
Indigo	Middle	439
	End	424
Violet	Middle	409
	End	396
Lavender	Middle	384
	End	372

ORTHOCHROMATISING PLATES.—Ordinary, or non-colour sensitive plates, may be orthochromatised by bathing in solutions of dyes. As a rule, such plates have a higher colour sensitivity than those coated with an emulsion to which the dye is added during the mixing, but they do not keep quite as well.

Blue-green and Green Sensitisers.—Acridine orange NO, made by Leonhardt of Mühlheim, was the old dye used. A saturated alcoholic solution was made and diluted with water; but this dye stains the gelatine so tenaciously that it cannot be removed except with an alcohol bath. It has been entirely replaced by pinaflavol (Hoechst) or the new dye dimethyl-styrylpyridine methiodide, suggested by Mills and Pope. This is used in an aqueous solution, 1:30,000 or 1:40,000, in which the plates are bathed for 3 minutes, rinsed and dried. This gives very even sensitiveness from the bright blue to the yellow at 560, then falling off rapidly to 620, and without the usual gap in the blue-green, characteristic of the eosine dyes.

Green and Yellow Sensitisers.—Erythrosine is the dye

generally used. The extra blueish kind should be used in a 1:5000 aqueous solution with the addition of 0.5 per cent of ammonia. This gives a strong yellow, orange and green sensitiveness, but a marked want of sensitiveness in the blue-green. For this reason the new dyes mentioned above may be substituted with advantage, but the proportion of ammonia should be reduced to one-tenth.

Green, Yellow and Orange Sensitisers.—To obtain sensitiveness up to 620 to 640 in the orange, any of the following dyes may be used: isocol (Bayer), orthochrome T, pinaverdol (Hoechst), sensitol green (Ilford), or pinachrome (Hoechst). These should be used in about a 1:50,000 solution, with the addition of a little ammonia, not more than 0.01 per cent. The plates should be bathed for 3 or 4 minutes, then rinsed in alcohol, and dried as quickly as possible. Instead of using ammonia in the bath, it is preferable to use about 0.02 per cent of borax, which does not tend to give so much fog. The dilute dye solutions have a tendency to deposit a flocculent precipitate, and this can be prevented by adding from 20 to 40 per cent of ethyl or methyl alcohol or acetone to the bath, but this method does not give such good colour sensitiveness as with aqueous solutions. A deep red safelight may be used until the plates are covered with the dye solution, and then the rest of the operations should be conducted in darkness, or a green safelight used.

Panchromatic and Red Sensitisers.—Pinacyanol (Hoechst) or sensitol red and sensitol violet (Ilford) may be used for red sensitising and panchromatic plates, the violet dyes giving the best all round results; though a mixture of orthochrome or sensitol green with the violet may be used, in the ratio of 2 of the former to 1 of the latter. The total strength of the bath should not be more than 1:75,000. Ammonia or borax should be used in the same way and the same precautions

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taken as to the use of a green safelight. These dyes sensitise to about 720. For the extreme red and infra-red, dicyanine must be used. This does not sensitise for green at all, and great care must be taken in protecting the dye and its solution from light.

Only perfectly clean glass dishes should be used for bathing plates; old porcelain dishes and metal tanks are to be avoided, as, in the former case, they are apt to contaminate the dye baths from traces of old solutions held in the cracks, and metals tend to reduce the dyes and cause fog. Home-bathed plates will not keep well, and the sooner they are used the better.

The following method of hypersensitising plates gives extraordinary colour sensitivity and speed, but the plates will not keep more than about 36 hours. Three stock solutions of dyes are required:

A. Pinaverdol	1 g	7.68 gr.
Alcohol, 90°	1000 ccm	16 oz.
B. Pinachrome	0.05 g	0.384 gr.
Alcohol, 90°	1000 ccm	16 oz.
C. Pinacyanol	0.05 g	0.384 gr.
Alcohol, 90°	1000 ccm	16 oz.
D. Solution A	405 ccm	6¾ oz.
Solution B	405 ccm	6¾ oz.
Solution C	210 ccm	3½ oz.

If absolutely correct rendering of the colours is required, the ratios of these solutions may have to be altered slightly. It will be understood also that the English dyes, sensitol green and sensitol red, may be used instead of the pinaverdol and pinacyanol with equally satisfactory results. Stock dye solution:

E. Stock solution D	400 ccm	6 oz., 192 min.
Alcohol	600 ccm	9 oz., 288 min.

F. Silver chloride	2 g	1.54 gr.
Ammonia, 22°	80 ccm	61 min.
Distilled water	920 ccm	16 oz.

The ammonia should have a specific gravity of about 0.92.

Sensitising bath:

G. Solution E	100 ccm	1 oz., 288 min.
Solution F	100 ccm	1 oz., 288 min.
Alcohol, 22.5°	800 ccm	13 oz.

This alcohol contains approximately 50 per cent water. The plates should be bathed at as low a temperature as possible, the dish rocked for 3 minutes, the plates rinsed for 1 minute, and then dried as rapidly as possible. It is possible to take snapshots with plates thus bathed in well-lighted rooms with a lens working at $f:4$.

Various formulas have been given for panchromatising plates, some of which are given here. As a rule, the fastest plates should not be used, as they are more liable to fog on keeping; and a clean working plate should be chosen.

Wallace's Bath.—

Pinacyanol	15 ccm.	115 min.
Pinaverdol	12 ccm	92 min.
Homocol	12 ccm	92 min.
Ammonia	35.7 ccm	270 min.
Alcohol	410 ccm	6¾ oz.
Water	590 ccm	9½ oz.

Bathe for 4 minutes, rinse in alcohol for 30 seconds, dry. Sensitises to 720, without any gap in the blue-green. Dicyanine may be used instead of the homocol with slightly greater speed.

Greenfield's Bath.—This bath is specially intended for tank work, but the solution should not be used more than twice:

Pinachrome	3 ccm	23 min.
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Pinacyanol	2 ccm	15 min.
Water	1000 ccm	16 oz.

As all the isocyanines are decolourised by the carbonic acid dissolved in water, this bath would be rapidly decolourised, and in this state would not give such good results. A small addition of ammonia or borax is essential. In the above baths the dyes are used in 1:1000 alcoholic stock solution.

George's Formula.—

Pinaverdol	13.75 ccm	105 min.
Homocol	9 ccm	69 min.
Pinacyanol	11.5 ccm	88 min.
Ammonia	68.75 ccm	528 min.
Alcohol, 90%	376 ccm	6 oz.
Water to	1000 ccm	16 oz.

This bath is too strong in ammonia. The dyes in the above bath should be used in a 1:2000 alcoholic stock solution.

Monpillard's Formula.—

Pinacyanol or dicyanine	5 ccm	38 min.
Homocol	5 ccm	38 min.
Ammonia	0.1 ccm	0.77 min.
Water	1000 ccm	16 oz.

With dicyanine the sensitiveness extends to 750, with pinacyanol to 680. Stock dye solution 1:1000 alcohol.

DESENSITISING PLATES.—Lüppo-Cramer found that by bathing plates in certain dye solutions both ordinary and colour-sensitive plates could be desensitised after exposure and thus be worked in a bright orange or yellow light without fog. Phenosafranine in a 0.05 per cent solution may be used with one minute's bathing in the dark, or 10 per cent of a 0.5 per cent solution may be added to the developer with equally good results. Other dyes of this class that act well are dimethylsafranine, amethyst violet, giroflé, safranine MN, phenosafranine and cresosafranine. Unfortunately, these

dyes are very tenaciously retained by the gelatine and can only be discharged by a nitrite bath, such as :

Sodium nitrite	1 g	8 gr.
Hydrochloric acid	10 ccm	80 min.
Water	1000 ccm	16 oz.

or a 2 per cent alum solution with an equal volume of hydrochloric acid. The Hoechst dye works have introduced two new dyes for the same purpose, pinakryptol and pinakryptol green; the latter is the more soluble of the two and may be used as a preliminary bath or added to the developer, but the strength should be only 1:5000. Neither of these dyes stain the gelatine so much as the safranines. Lumière and Seyewetz have found that aurantia in a 1:1000 solution acts as a good desensitiser, and also toluylene red. This desensitising process is also applicable to screen-plates.

ORTHOCHROMATIC FILTERS.—Yellow filters are used to cut down the excessive blue and violet sensitiveness of colour-sensitised plates. The quantity of dye given is calculated in grams of the dry dye per square meter, or grains per 1000 square inches. It is advisable to dissolve the dyes in distilled water and add to the gelatine solution, previously prepared and filtered.

To make the gelatine solution, immerse 125 g (614 gr.) soft gelatine in 500 ccm (8 oz.) distilled water, stir for 5 minutes, and pour off the water. Again add the same quantity of water, allow the gelatine to soak for 10 minutes with an occasional stir, and pour off. Repeat the operation, allowing the gelatine to soak for 15 minutes, and pour off the water. Drain out as much water as possible, then melt the gelatine on a water bath in the water that it has absorbed. Add sufficient distilled water to make the total bulk 1000 ccm (16 oz.), and filter through glass wool or well-washed absorbent cotton.

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To make the dyed gelatine, the following quantities of filter yellow (Hoechst) should be used (Hübl):

No. 1. Filter yellow	0.5 g	4.97 gr.
No. 2. Filter yellow	1.0 g	9.94 gr.
No. 3. Filter yellow	2.0 g	19.88 gr.
No. 4. Filter yellow	3.4 g	33.8 gr.
No. 5. Tartrazine	3.0 g	29.84 gr.

The above quantities of dye should be dissolved in 50 to 100 ccm (384 to 768 min.) distilled water, and added to sufficient gelatine solution to make 700 ccm (15 oz., 435 min.) in all. This quantity should be coated on 1 qm or 1000 sq. in. of glass.

The increase of exposure with these filters varies with the colour-sensitiveness of the plates used, but the following will be some guide:

No. 1. Increase from $\frac{1}{2}$ to 2, according to plate. Can be used for instantaneous work and portraiture in the studio.

No. 2. Increase from 2 to 6. Can be used for distant mountains and costume studies. Yellow reproduced the same tone as blue.

No. 3. Increase from 6 to 8. Gives yellow much brighter than blue.

No. 4. Increase from 4 to 12. Correct luminosity filter.

No. 5. Increase from 4 to 15. Contrast filter. Reproduces blue like black, yellow like white. Suitable for cloud studies in which the sky is to be very dark, and furniture.

König recommended the following quantities of filter yellow to the same areas as above:

No. 1. Filter yellow	0.146 g	2.25 gr.
No. 2. Filter yellow	0.292 g	4.5 gr.
No. 3. Filter yellow	0.594 g	9.0 gr.
No. 4. Filter yellow	1.167 g	18 gr.

The increase in exposures should be 1.3, 1.7, 2, and 3 respectively.

Plate Backing

CARAMEL BACKING.—A non-actinic coating is applied to the back of glass plates to prevent halation, or the reflection of brightly lighted objects from the back surface of the glass. To be effective the backing must be in optical contact with the glass, and should theoretically be of the same refractive index.

Caramel or burnt sugar does not dry, but a crystal caramel powder, which dries hard, is obtainable commercially. This can be made as follows: place some white sugar in a stewpan and heat over the gas, stirring continuously until it melts. The temperature will then rise very rapidly to 222° C. (430° F.). Continue heating for 15 minutes, stirring all the time; bubbles of gas will be given off and a clear red fluid formed, which gradually thickens. The heat should not be continued more than 5 minutes longer at this stage, or the product will be spoiled. Then pour out on a sheet of metal or slate, and it should set hard and brittle. Break up into small pieces, place in a wide-mouthed bottle, add water equal to one third the height of the fragments, and leave for three days. Add ten times the volume of wood or denatured alcohol or methylated spirit, and shake well two or three times in 24 hours. Pour off the alcohol, which extracts the sticky part, and add sufficient water to the residue to make a fairly thick liquid. This dries hard but brittle. If one eighth of the original mixture, before the addition of the alcohol, be added, it loses its brittleness. Instead of dissolving in water, it may be poured out in a flat dish, allowed to dry, and then powdered. A suitable backing mixture is:

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Crystal caramel powder	500 g	5 oz.
Gum arabic	250 g	2½ oz.
Water	750 ccm	7½ oz.

Or:

Caramel powder	500 g	10 oz.
Water	250 g	5 oz.
Denatured alcohol (methylated spirit)	150 g	3 oz.

Mix and strain through muslin. Ordinary caramel or the above may be mixed with a thick gum arabic solution and burnt sienna or lampblack in equal weights. Or the following may be used:

Dextrine	50 g	¼ oz.
Crystal caramel	200 g	1 oz.
Ammonium chloride	4.5 g	10 gr.
Water	200 ccm	1 oz.
Alcohol	200 ccm	1 oz.
Glycerine	25 ccm	60 min.

Work up into a stiff paste.

ASPHALT BACKING.—Dissolve powdered asphalt in benzole, chloroform or, preferably, carbon tetrachloride, to form a dark brown liquid. Apply with a brush. This dries very rapidly.

CORNU'S BACKING.—

Oil of cloves	6 parts
Turpentine	7 parts
Lampblack	q. s.

Use enough lampblack to form a stiff paste. This takes a long time to dry and has a very strong smell.

STAINED COLLODIONS.—

Aurine	4.5 g	35 gr.
Enamel collodion	1000 ccm	16 oz.

Or:

Nigrosine, spirit soluble	10 g	77 gr.
Pyroxyline	30 g	230 gr.
Methyl alcohol	400 ccm	6½ oz.
Ether	600 ccm	9½ oz.
Castor oil	60 ccm	460 min.

Or:

Celluloid scraps	45 g	350 gr.
Nigrosine	10 g	77 gr.
Amyl acetate	250 ccm	4 oz.
Acetone	750 ccm	12 oz.

This takes some hours to dry. By replacing the amyl acetate with methyl alcohol, a much quicker drying mixture is obtained. These, like the asphalt backings, are sometimes difficult to remove, but friction with soap and water readily removes them.

BLACK BACKING.—For ordinary, non-colour-sensitive plates, the following may be used:

Burnt sienna, paste	750 g	¾ lb.
Dextrine	63 g	1 oz.
Water	63 ccm	1 oz.
Phenol (carbolic acid)	5 ccm	50 drops

For panchromatic plates, use ivory sienna black instead of the burnt sienna. These pigments can be obtained from any colourman, ground in water. Mix the dextrine and water, heat until dissolved, and then work in the colour paste and the carbolic acid, which is merely added to prevent the stock from growing mouldy.

CHREVIOT'S BACKING.—

White castile soap	60 g	46 gr.
Alcohol, 90°	1000 ccm	16 oz.

Dissolve in a water bath and add:

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Erythrosine	10 g	77 gr.
Aurine	8 g	61 gr.
Ivory black	8 g	61 gr.

This will dry in 10 minutes and can be readily removed with a damp sponge.

QUICK-DRYING SOAP BACKING.—

Soap	45 g	346 gr.
Denatured alcohol (methylated spirit)	1000 ccm	16 oz.
Erythrosine	14 g	107 gr.
Aurine	14 g	107 gr.

Scrape the soap into fine powder or shavings, digest in the alcohol for a week with occasional shaking, add the dyes, and filter.

BACKING SHEETS.—Black or red paper, gummed or coated with dextrine on one side, may be used, but is less efficient than any of the others. Sheets that can be repeatedly used may be made by coating cloth or paper with:

Soft gelatine	1 part
Water	2 parts
Glycerine	1 part

Soak the gelatine in the water and melt in a water bath; add the glycerine, then add lampblack, nigrosine, water soluble, or a red dye to colour. Or printing-out paper may be exposed to light until dark, then washed, dried, soaked in glycerine, and squeegeed to the back of the plate.

OXGALL (BOLAS).—

Oxgall, purified	1 part
Gum arabic mucilage	4 parts
Red or black water colour	1 part

The water colour should be obtained in a tube ground up in water. This should be applied with a stiff brush, and a sheet of black celluloid or paper applied.

Focus and Optics

TO FIND THE FOCAL LENGTH OF A LENS.—Many methods have been suggested for finding the focal length, equivalent focus, or focus of a lens, and many of them require a knowledge of the position of the nodal point of emergence. This can be found by calculation, but it can also be determined by temporarily mounting the lens in a V-shaped groove on a small block of wood, so that the lens can be moved to and fro. Or take a large flat cork and drive a nail through the center, so that the cork will turn on this as an axis. Fasten the lens to the cork by a rubber band, and focus some very distant object, such as the sun or moon, on a piece of card or ground glass also temporarily held on a cork. When the image is quite sharp, rotate the lens, and, if the image moves, the nodal point of emergence of the lens is not over the point of rotation of the cork. The lens should be shifted to and fro and the image again focussed until it no longer moves with the rotation of the lens. Then the node of emergence is exactly over the axis of rotation, and this is the point from which the focal length should be measured.

The following method is accurate and calls for measurements which are easily made. Focus a foot rule to a definite size, measure the distance between the rule and the image, and call this D . Then focus to a larger size, again measure the distance as before, and call this d . Then the following formula will give the focus:

$$\frac{d - D}{\left(\frac{r^2 + 1}{r}\right) - \left(\frac{R^2 + 1}{R}\right)}$$

R being the ratio of image to object in the first case, and r

that in the second case. Example: $D = 62.7$ in.; $d = 72.2$ in.; $R = 4$ and $r = 5$; then $72.2 - 62.7 = 9.5$; then $(5 \times 5 + 1) \div 5 = 26/5$ and $(4 \times 4 + 1) \div 4 = 17/4$; then $26/5 - 17/4 = 19/20$; and $9.5 \div 19/20 = 10$ in., the equivalent focus of the lens.

Another Method.—This method can be carried out in any room. First focus on a very distant object, and mark the extension of the camera; then focus on a comparatively near object, that is to say, one in the length of an ordinary room, again mark the position of the camera, and call the distance between the two marks x . Again focus on a still nearer object, again measure the distance beyond the infinity mark, and call this distance y . Let B be the distance between the two objects, then the focus $f = \sqrt{Bxy \div y - x}$. Suppose the distance of one object is 144 in. and that of the other 96 in., then $B = 144 - 96 = 48$. And suppose the extension of the camera beyond the infinity or distant mark for the object at 12 ft. was 1 in. and at 8 ft., $1\frac{1}{2}$ in., then $f = \sqrt{48 \times 1 \times 1\frac{1}{2} \div 1\frac{1}{2} - 1} = \sqrt{72 \div \frac{1}{2}} = \sqrt{144} = 12$. In this method, if the lens is moved in focussing, the distance between the object at the two positions, or B , must be ascertained by measuring from some part of the camera front. If, on the other hand, the focussing screen is moved and the lens remains stationary, we need only measure the distance between the two positions of the object.

Another Method.—Set up a foot rule on a wall, and shift the camera until an image is obtained on the ground glass that is exactly the same size as the rule; naturally, how much of the rule is included depends on the size of the ground glass. Then measure the distance between the rule and the image, divide this by 4, and the result will be approximately the equivalent focus.

Or set up the foot rule as in the previous method, and

make the image not more than one-fourth of the size of the object; then make a negative of the foot rule, and, calling the distance between the rule and sensitive plate D and the ratio of reduction r , which can be found by measuring the length of the image on the negative and dividing into the length of the foot rule, then $f = D \times r \div (r + 1)^2$. Example: a rule of 150 mm was found to give an image of 13.4 mm, D was 800 mm, then $r = 150 \div 13.4 = 11.19$; then $f = 800 \times 11.19 \div (11.19 + 1)^2 = 67.78$ mm.

Another Method.—Focus on a near object, then move the object further away from the lens by a distance D , refocus, note the distance through which the focussing screen has been moved, and call this a . Again move the object away from the lens another distance equal to the first distance D , and call the distance the focussing screen has moved b , then $f = \sqrt{2D \times b \times a (b + a) \div (a - b)}$. The lens must remain stationary in this method. Let $D = 96$, $a = 2$, $b = \frac{1}{2}$; then $f = \sqrt{2 \times 96 \times \frac{1}{2} \times 2 (\frac{1}{2} + 2) \div (2 - \frac{1}{2})} = \sqrt{480 \div 1.5} = 14.61$.

Another Method.—Reverse the lens in its flange, focus on infinity, or a very distant object, and call this distance b . Replace the lens in its ordinary position, and again focus on infinity. Now focus on a near object at a distance D , measure the extension of the camera beyond the infinity mark, and call this y ; then $f = \sqrt{(D - b)y}$. Let $D = 48$, $b = 8$, $y = \frac{1}{2}$; then $f = \sqrt{(48 - 8)\frac{1}{2}} = 4.472$.

Pinhole Method.—The focus can also be found by means of a pinhole. Focus on infinity with the lens, and measure the size of the image or make a negative. Then place a pinhole in the position of the lens, and produce an image of the distant object exactly the same size; the distance of the pinhole from the image is the focus. A simple thin lens may be used instead of the pinhole. Or, if a lens of known focus

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is available, it is only necessary to measure the size of the two images, when both lenses are focussed on the same distant object, and the focal lengths are proportional to the sizes of the two images.

A Geometrical Method.—Focus two distant objects, as *A* and *B* in Fig. 1, and let *C* and *D* be the images of these

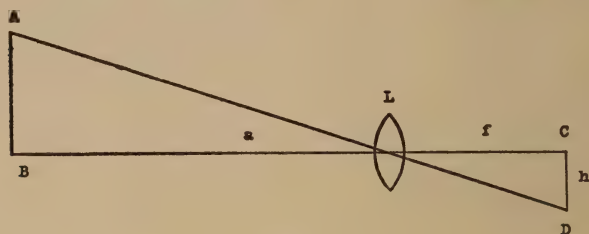


Fig. 1

objects; then $f = h \div \tan a$, a being the angle between AC and BD . Measure the length h , the distance between the images of the two objects, and also CL , their distance from the lens; then $f = h \div (CD \div CL)$. Let CD or $h = 4$ in. and $CL = 8$ in.; then $f = 4 \div (4 \div 8) = 8$.

Another Geometrical Method.—At a distance a , at least 100 times the focus, set off at right angles to the axis of the lens two marks $\frac{1}{4} a$ distant from the axis. The distance between the two images on the screen will be $\frac{1}{2} f$.

Grubb's Method.—At each side of the focussing screen make a pencil mark equidistant from the center. Place the camera flat on a sheet of white paper in front of a window. Focus on a very distant object, so that its image falls exactly on one pencil mark. Then draw a pencil line along the side of the camera, using the edge of the camera as a straight edge. Shift the camera so as to bring the image of the same object on to the other pencil mark on the ground glass, and again draw a line along the side of the camera, using the same

side as before. Produce these two lines so that they meet in the point *A*, Fig. 2. Bisect the angle *BAC* by the line *AD*,

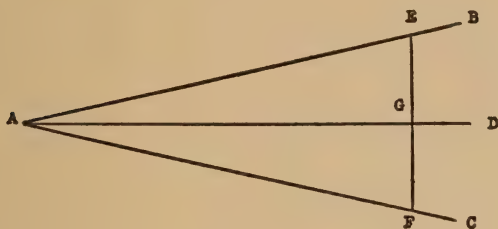


Fig. 2

and draw a line *EF* at right angles to this line, equal to the separation of the pencil marks on the ground glass; the focal length is then *AG*.

Smith's Method.—T. Smith, of the National Physical Laboratory, London, has given another method of finding the equivalent focus of a lens, based on the focussing of the image of a distant object on the lens axis upon the ground glass of the camera, using first the complete lens and then each component separately. The optical rule that serves as a basis of the method is that the focus of a lens of focal length *f* is at a distance equal to $fF \div f'$ from that of the combination of focal length *F* formed by placing in front of the first lens another of focal length *f'*. The method is carried out as follows: fit the complete lens to the camera, and focus sharply on a distant object. Mark the position of some part of the lens front or moving baseboard against a fixed part of the camera. Now remove the front combination, and again focus on the object, noting the distance *d* through which the lens front requires to be racked out; this distance is $fF \div f'$ in which *F* is the focal length of the whole lens and *f* and *f'* those of the combinations. Now focus again with the whole

lens on the same object, the lens being placed with the back combination to the front. Mark the position as before, then refocus after removing the front combination, really the back one now in front. The distance d' between the two positions is $f'F \div f$. Hence $dd' = F^2$, that is to say, by multiplying the two distances d and d' together and extracting the square root, we get the focal length.

Lockett's Method.—A. Lockett suggested the following method: First draw two short vertical lines at about the center of the focussing screen, exactly 1 inch apart and parallel with each other. Focus sharply on a far distant object, such as a remote church spire or factory chimney, and mark carefully on the camera baseboard the exact position of any convenient part of the moving lens front. This may be called the infinity mark. Now measure off 1 inch in advance of this mark, and rack out the camera until the same point of the front is against this 1-inch mark. Fix up a foot rule at about the height of the lens, and move the whole camera to and fro, without any other adjustment, until the rule is in the sharpest possible focus at full aperture, and with the commencement or zero of the graduations coinciding with one of the pencil lines. Then the number of inches of the rule seen on the ground glass between the two pencil lines will be equal to the focal length of the lens. This method is based on the following reasoning: let F be the equivalent focus, and r the ratio or proportion between the size of the image and the object. Then the minor conjugate focus, or the distance from lens to ground glass, is $F + F \div r$. When the camera front is set 1 inch from the infinity mark, then $F \div r$ equals 1 inch and must also be equal to $F \div F$; therefore r equals F . It is not essential to adhere to the 1-inch extension, and a greater distance will eliminate errors in

measurement, but the distance between the marks on the ground glass must always be the same as the extension of the camera from the infinity mark.

DEPTH OF FOCUS SCALE.—Decide what stops the scale is to be constructed for. As a rule, it will be found sufficient to calculate for $f:8$, $f:16$, $f:24$, etc., as with larger apertures the scale becomes too confused, and one rarely uses a larger aperture than $f:8$ for snapshot work. Draw a scale each division of which is equal to one-hundredth of the aperture, this being the assumed diameter of the circle of confusion; if this degree of sharpness is not considered sufficient, one may adopt one-two-hundredth or smaller, but, obviously, the smaller the divisions the more confused the scale and the less value practically. Besides that, one cannot estimate the distance of an object with sufficient accuracy for the smaller scales. Utilising the formula $100 \times \text{focus squared} \div \text{ratio aperture}$ ($100 F^2 \div r$), find the nearest points in focus. Mark off on the divided scale these distances, starting from the infinity point, as in Fig. 3.



Fig. 3

Construct another scale of like dimensions and divisions, and mark off with the stop apertures only, starting in the center as in Fig. 4.



Fig. 4

By placing Fig. 4 over Fig. 3 and sliding it along so that the arrow in the center marks the distance focussed on, one can at once read off under the stop numbers the distances which

will appear sharp in front of and behind the object focussed for. The following table shows the distances for a 6-inch lens starting with $f:8$, though in the scales only the nearest whole numbers are given:

$$100 \times 6^2 \div f:8 = 450 \text{ in.} = 37 \text{ ft. } 6 \text{ in.}$$

$$100 \times 6^2 \div f:16 = 225 \text{ in.} = 19 \text{ ft. } 9 \text{ in.}$$

$$100 \times 6^2 \div f:24 = 150 \text{ in.} = 12 \text{ ft. } 6 \text{ in.}$$

$$100 \times 6^2 \div f:32 = 112\frac{1}{2} \text{ in.} = 9 \text{ ft. } 4\frac{1}{2} \text{ in.}$$

$$100 \times 6^2 \div f:40 = 90 \text{ in.} = 7 \text{ ft. } 6 \text{ in.}$$

FOCUSSING SCALE.—To construct a focussing scale, draw a line equal in length to the equivalent focus of the lens, mark off exactly the half, third, fourth, sixth, eighth, etc., and add 1 to each division; this will give a scale as below. Multiply the numbers below the line by the focus of the lens, and the result will be the distances in inches at which an object will be sharp, if the lens be placed at this point. To fix this scale to a camera, focus first on the clouds, or a very distant object, mark the baseboard at any convenient part of the camera front, and place *B* even with this mark, the scale extending, obviously, from this mark away from the rear of the camera.

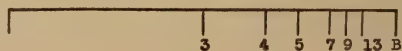


Fig. 5

DEPTH OF FOCUS.—Welborne Piper suggests that, knowing the hyperfocal distance for the stop in use and the distance of the object in sharp focus, if we divide the product of these two distances by their sum, the result will be the distance of the nearest object in focus; if their product is divided by their difference, the result is the distance of the farthest object in focus. Example: suppose we are focussing with a 6-inch lens on an object 10 ft. away, taking $1/100$ in. as the circle of confusion. The depth constant for the lens is

$100 \times 6^2 = 3600$ in. = 300 ft. The hyperfocal distance, which is always equal to the focal length multiplied by the diameter of the aperture, and divided by that of the circle of confusion, is therefore for a 6-inch lens at $f:6$, $300 \div 6$ or 50 ft. When focussing on 10 ft., the near depth is $(50 \times 10) \div (50 + 10) = 8 \frac{1}{3}$ ft. The limit of far depth is $(50 \times 10) \div (50 - 10) = 12 \frac{1}{2}$ ft. When focussing on infinity, the nearest object in focus is at the hyperfocal distance, and depth extends from that point to infinity. When the hyperfocal distance is focussed on, the nearest object in focus is at half the hyperfocal distance, and the farthest at infinity, so that depth extends from half the hyperfocal distance to infinity.

FOCUSSING RULES FOR HAND CAMERAS.—The following two simple rules may be useful to hand camera workers.

1. Applicable when the background is not very distant: Focus on a distance equal to twice the product of the greatest and shortest distances, divided by their sum. Example: Suppose the subject to be a street scene with a house 20 yards away, a man 5 yards away, and both are required to be sharp; then $(20 \times 5) \div (5 + 20) \times 2 = 8$ yards.
2. Applicable when the background is infinity or very distant: Focus on a point just double the distance of the nearest point. Example: again suppose that the nearest point is 5 yards distant; then the point to focus on is $5 \times 2 = 10$ yards.

The following rule may also be used: square the focal length of the lens in inches, multiply by 100, divide by the f number of the diaphragm, and then divide by 2. Example: With a lens of 5 in. focus at $f:8$; $5 \times 5 \times 100 = 2500$; $2500 \div 8 = 312 \frac{1}{2}$, and $312 \frac{1}{2} \div 2 = 156$ in. Then everything beyond 156 in. (13 ft.) will be in focus if this plane be focussed on.

COMBINING LENSES.—To find the focal length of two lenses separated by a short distance, multiply the focal lengths

together, and divide by their sum less the distance of separation. Let f' and f'' be the foci and d the separation of the two lenses; then the final focal length will be $(f' \times f'') \div (f' + f'' - d)$. Example: a 6-inch and an 8-inch lens are to be combined with a distance of separation of 1 inch; the focus will be $(6 \times 8) \div (6 + 8 - 1) = 48 \div 13 = 3\frac{1}{2}$. To find the focal length of a supplementary lens or magnifier to reduce or increase the focal length of a given lens, multiply the focal length F to be altered by the final focal length desired, and divide the product by the original focal length less the final focus. Example: it is desired to reduce the focal length of a 10-inch lens to 7 inches, then $10 \times 7 = 70$, $10 - 7 = 3$, and $70 \div 3 = 23\frac{1}{3}$. To reduce the focal length, positive or convex lenses must be used; to increase the focus, negative or concave lenses must be used; and, in this case, the focus of the lens to be added is prefixed by the minus sign in the formula. Example: to lengthen a 7-inch lens to 10 inches, $7 \times 10 = 70$, and $7 - (+10) = -3$, therefore $70 \div -3 = -23\frac{1}{3}$. A very simple rule to remember as to the focus of a magnifier for reducing the focus, or, in other words, to take near objects close to the camera, is that the focus of the supplementary lens must be equal to the distance of the object. In this calculation the separation of the lenses has been neglected; to take this into consideration is a refinement that merely complicates calculations.

RATIO APERTURE OF DIAPHRAGMS.—The ratio or effective aperture of the stops or diaphragms does not coincide with their actual diameters in consequence of the condensation of the light by the front lens component in compound lenses. To determine the correct ratio aperture, focus the lens for parallel rays, that is, for a very distant object; then replace the focussing screen with an opaque card, in the center of which is a pinhole. In a dark room place a light behind the

pinhole, and a circle of light will be found on the front glass of the lens; the diameter of this circle will be the true aperture of the stop, and dividing the focal length by this gives the true ratio aperture. As it is sometimes difficult to see the circle of light on the glass, the latter may be dusted with talc, which makes it more readily visible. Or a small piece of bromide paper may be cut and placed inside the cap of the lens, and a fairly long exposure given to the light passing through the pinhole and the lens. On development the diameter of the black circle is the diameter of the ratio aperture. Another method is to focus a bright spot of light at infinity or a great distance, and then move the focussing screen until the spot of light becomes a disk of any definite diameter, say, half an inch. Then the distance the focussing screen was moved divided by the diameter of the disk of light is the diameter of the ratio aperture. To find the diameter of the stops for a lens, the following approximate method may be adopted: Find the equivalent focus F of the lens, measure the distance between the two outer surfaces of the front and back lens, call this d ; then the diameter of the stop $f:x$ will be $(F - \frac{1}{2}d) \div x$. Example: focus of lens, 16 inches, distance between the surfaces or d , 2 inches; if the desired stop is $f:8$, then $16 - (\frac{1}{2} \times 2) \div 8 = 16 - 1 \div 8 = 1\frac{7}{8}$ inches, the diameter for $f:8$.

PIPER'S TABLE OF ANGLES OF VIEW.—To find the angle included on any given plate, divide the diagonal of the plate by the equivalent focus of the lens. The quotient T is equal to twice the tangent of half the angle, but the value of the angle can be found very nearly from the following table:

If T is less than	The angle is less than	If T is less than	The angle is less than
0.3	17°	1.7	81°
0.35	20°	1.8	84°

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If T is less than	The angle is less than	If T is less than	The angle is less than
0.4	23°	1.9	87°
0.45	$25\frac{1}{2}^\circ$	2.0	90°
0.5	28°	2.1	93°
0.55	31°	2.2	$95\frac{1}{2}^\circ$
0.6	$33\frac{1}{2}^\circ$	2.3	98°
0.65	36°	2.4	$100\frac{1}{2}^\circ$
0.7	39°	2.5	103°
0.75	$41\frac{1}{2}^\circ$	2.6	105°
0.8	44°	2.7	107°
0.85	$46\frac{1}{2}^\circ$	2.8	109°
0.9	$48\frac{1}{2}^\circ$	2.9	111°
0.95	51°	3.0	$112\frac{1}{2}^\circ$
1.0	53°	3.2	116°
1.1	58°	3.4	119°
1.2	62°	3.6	122°
1.3	66°	3.8	$124\frac{1}{2}^\circ$
1.4	70°	4.0	127°
1.5	74°	4.3	130°
1.6	77°	4.7	134°

To determine the covering angle, the diameter is taken as equal to twice the distance from the principal axis of the lens to the farthest corner of the plate. To determine the view angle, we take simply the diagonal of the plate as the diameter. The diagonals of ordinary plates and films are:

$2\frac{1}{4} \times 3\frac{1}{4} \dots 4.0$ in.	5 x 7 8.6 in.
$2\frac{1}{2} \times 4\frac{1}{4} \dots 4.9$ in.	5 x $7\frac{1}{2} \dots 9.0$ in.
$3\frac{1}{4} \times 3\frac{1}{4} \dots 4.6$ in.	$6\frac{1}{2} \times 8\frac{1}{2} \dots 10.7$ in.
$3\frac{1}{4} \times 4\frac{1}{4} \dots 5.3$ in.	8 x 10 12.8 in.
$3\frac{1}{4} \times 5\frac{1}{2} \dots 6.4$ in.	10 x 12 15.6 in.
4 x 5 6.4 in.	16 x 20 25.6 in.
$4\frac{3}{4} \times 6\frac{1}{2} \dots 8.0$ in.	20 x 24 31.2 in.

CORRECTION FOR NON-ACHROMATIC (SPECTACLE) LENSES.

—After focussing, the distance between the lens and plate must be decreased by approximately $1/40$ the focal length of the lens, in the normal use of the lens when photographing distant objects. In portraiture, copying, etc., the correction is greater, as follows:

Ratio of reduction	Infin.	1/10	1/5	3/10	4/10	½	6/10	7/10	4/5	same size
Correction (% of focal length)	2	2.2	2.4	2.6	2.8	3	3.2	3.4	3.6	4

TELEPHOTO FORMULAS.—Let M be the magnification, i. e., the number of times the image produced by the complete lens is larger than that produced by the positive lens alone; F the focal length of the complete lens; f' the focal length of the positive lens; f'' the focal length of the negative lens; E the camera extension from negative lens to plate. To find the magnification M : Divide the camera extension by the focal length of the negative lens, and add 1, or $M = (E \div f'') + 1$. To find the camera extension: Multiply the focal length of the negative lens by the magnification minus 1, or $E = f'' (M - 1)$. The focal length of the whole lens for distant objects equals the focal length of the positive lens multiplied by the magnification, or $F = Mf'$. For near objects when reducing N times, $F = (mE + f') \div (mN + 1)$, in which $m =$ the ratio of f' to f'' , i. e., $f' \div f''$ (Dallmeyer).

Assume the same notation as above. The separation of the positive from the negative lens $= (f' - f'') + (f'' \div M)$. Example: Suppose the positive lens has a focus of 7 in., the negative a focus of 3 in., what separation will be required for 4 magnifications? Ans.— $(7 - 3) + (3 \div 4) = 4\frac{3}{4}$. An alternative formula giving the separation necessary to obtain a telephoto combination of a desired focal length is $(f' - f'') + f' (f'' \div F)$. Example: suppose the positive lens is 9 in. focus and the negative 4 in., what separation is required

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to make the combined focus 16 in? Ans.— $(9 - 4) + 9 \times (4 \div 16) = 5 + 9 \times \frac{1}{4} = 5 + 2\frac{1}{4} = 7\frac{1}{4}$ in. Where a scale of magnification is marked, as on the ordinary type of adjustable mount, and another magnification is desired that is not marked, let M' stand for any existing marked magnification, M'' the magnification desired. Then $f'' \times (M' - M'') \div (M' \times M'')$ will be the increase of separation required. Example: Suppose a magnification of 5 be wanted, and the nearest mark is 3, the focus of the negative lens being $4\frac{1}{2}$. Then $4\frac{1}{2} \times (5 - 3) \div (5 \times 3) = 4\frac{1}{2} \times 2/15 = 3/5$ in., which is the necessary extra separation readily measured from the existing mark for 3 magnifications. When the focus of the negative lens is not known, it is easy to find it from the distance between any two magnification marks on the mount. The rule is: multiply the two magnifications together and divide by their difference, multiplying the quotient by the distance D between the two marks; $(M' \times M'') \div (M' - M'') \times D$. Example: suppose the distance between the marks 8 and 4 on a telephoto mount is $\frac{3}{4}$ in., then $(8 \times 4) \div (8 - 4) \times \frac{3}{4} = 32/4 \times \frac{3}{4} = 6$ in., which is the required focus (Lockett).

PINHOLE EXPOSURE.—The correct exposure is, with the small pinholes used in practice, always greater than that calculated on a basis of relative aperture ratios. The inverse square law cannot be applied in calculating relative exposures at varying plate distances from one and the same pinhole. Using a pinhole made with a No. 12 needle, the pinhole exposure factor by which the aperture ratio numbers must be multiplied varies from 1.6 to 1.42 as the plate distance diminishes from 254 to 128 mm (Carnegie).

Watkins finds that it is better to expose with a pinhole for 50 per cent longer than the exposure calculated on the ratio aperture, and gives the following table based on 1/40 instead

of $1/60$ inch, the numbers being called Watkins-Power, or W. P. Nos.

W. P. Nos.	Decimals of inch	Nearest vulgar fractions	Nearest needle size	Working distance
1	.160	$1/7$	..	.....
2	.080	$1/13$	..	.....
3	.053	$1/19$	1	40 in.
4	.040	$1/25$	4	20 in.
5	.032	$1/31$	5	14 in.
6	.027	$1/38$	7	10 in.
7	.023	$1/44$	8	8 in.
8	.020	$1/52$	10	5 in.

Multiply the W. P. No. of the aperture by the working distance from the plate. Use the result as the f number with which to calculate the exposure by table or meter. Whatever the calculated result is in seconds or fractions of a second, expose that same number of minutes or fractions of a minute.

To find the best diameter of pinhole for a given extension of camera: divide the square root of the extension by 120. Example: extension = 11 in., square root of 11 = 3.316, and this divided by 120 = 0.0276 in. or approximately $1/36$ in.

To find the extension of camera for a given size hole, multiply the diameter of the hole by 120, and square the result. Example: diameter = $1/40$, then $1/40 \times 120 = 3$, and $3 \times 3 = 9$ in.

CONJUGATE FOCI.—The relative distances between the negative and lens, and lens and image, for enlarging and reducing, that is, copying in the camera or making lantern slides, can be found by the following simple rule: divide the longer side of the enlargement desired by the longer side of the negative, and the result will be the “times” of enlargement; it should be noted that this is linear and not area enlargement.

Then multiply the focus of the lens by the times of enlargement plus 1, and the result will be the distance between lens and sensitive surface. This distance divided by the times of enlargement will give the distance between the lens and negative. Example: to find the distances for enlarging a 4 x 5 negative to 16 x 20, the times of enlargement = $20 \div 5 = 4$. Using a $6\frac{1}{2}$ in. focus lens, $6\frac{1}{2} \times (4 + 1) = 32\frac{1}{2}$ and $32\frac{1}{2} \div 4 = 8\frac{1}{8}$ in. The greater distance is called the major conjugate focus and the lesser the minor conjugate. In reducing or copying, these distances are reversed, that is, the major conjugate or greater distance is between the subject and the lens and the minor between the lens and the sensitive surface.

HOW TO CARE FOR HIGH GRADE LENSES.—The lens should be capped when it is not in use. Avoid sudden and extreme temperature changes. The lens should not be exposed to acid fumes. Avoid placing or leaving lens where dampness or moisture may collect on it. Do not permit lens to fall, or subject it to a sudden jar. Occasional cleaning is not only advisable but necessary when dust, finger marks or moisture show on the lens surfaces. For this a camel's hair brush and a clean, soft, linen cloth are desirable. Proceed as follows: Remove dust with camel's hair brush. Breathe on lens surface, and with cloth wipe lightly with a circular movement. If finger or dust marks cannot be removed, rub the surface gently with a tuft of cotton moistened with clean warm water. Dry the surface with a piece of clean linen cloth. Under no circumstances use abrasives or any kind of polishing or cleaning material. Never use acids, alcohol, alcoholine or other solvents on the lens surfaces or on the mount. Only in extreme cases should lens elements be removed from their metal mounts to clean inner surfaces. When replacing same, see that they fit evenly and firmly in the mount.

Exposure

TIMING SHUTTER SPEEDS.—Using a pendulum for this purpose, the speed of the bob is in feet per second

$$2 \times gl \left(\sin^2 \frac{B}{2} - \sin^2 \frac{C}{2} \right)$$

in which g = force of gravity at the place of experiment, 32.2 being sufficiently approximate, l = length of pendulum in feet, B the angular displacement from vertical of bob at its highest position, C the angular displacement from vertical of bob for position at which speed is required. From this a table can be calculated of the speeds of the bob over each 5 degrees of arc and also the total period of the pendulum (Collingridge).

THE AMERICAN PHOTOGRAPHY EXPOSURE-TABLES.*—Find numbers for subject, stop, light, month and hour, and plate. Add them, refer to table (page 60), and give exposure indicated. When the exposure fails to correspond with speed marking on shutter, use the nearest shutter speed, preferably the lower.

Subject.—

Sea (only) and clouds	1/2
Sea views, snow scenes, distant landscape	1
Open landscape with unimportant foreground	2
Average landscape with foreground	3
Landscape with dark foreground, groups in sunlight	4
Street scenes, buildings, groups	5
Portraits in shade	7
Indoor portraits	8 to 10
Interiors	8 to 16

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Stop.—

<i>f.</i> 2	2.3	2.8	3.3	4	4.7	5.6	6.7
1	1½	2	2½	3	3½	4	4½
U. S. 0.25	0.33	0.5	0.7	1	1.4	2	2.8
<i>f.</i> 8	11.3	16	22	32	45	64	
5	6	7	8	9	10	11	
U. S. 4	8	16	32	64	128	256	

Light.—

Intense sunlight (inky-black shadows)	0
Bright sunlight (strong shadows)	½
Faint shadow cast by sun	1
Dull (no shadows)	1½
Very dull (whole sky very dark)	2

If sunlight falls over one shoulder, add 0; if straight across subject, add 1; if sun is ahead, add 2. When using back combination only of R. R. or symmetrical lens, add 2, unless actual *f* value of stop is known and used.

LIGHT VALUES FOR VARIOUS LATITUDES.—The following tables show the value of the light for each hour of the day and month for various latitudes and are calculated for use with the *American Photography Exposure Tables*.

For 60° N.; Southern Siberia, Southern Alaska, Northern Canada, Iceland, Norway, Sweden, and Northern Russia.

A	P		May	Apr.	Mar.	Feb.	Jan.	
M	M	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	12	0	0	½	1	1½	2	3
11	1	0	½	1	1½	2	3	5
10	2	½	½	1	1½	2	4	6
9	3	½	1	1½	2	3	5	...
8	4	1	1½	2	3	5	...	...
7	5	1½	2	3	5	...	...	...
6	6	2	3	5	...	...	...	...
5	7	3	5	...	...	...	...	...
4	8	5	...	...	...	...	...	...
		Dec.	Nov.	Oct.	Sept.	Aug.	July	June
			Jan.	Feb.	Mar.	Apr.	May	

The months for latitudes north of the equator are given at the top of the tables, while those for the southern hemisphere are below.

For 53° N.; British Isles, Northern Germany, Southern Canada, and Southern Russia.

A	P		May	Apr.	Mar.	Feb.	Jan.	
M	M	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	12	0	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	3
11	1	0	0	$\frac{1}{2}$	1	2	3	4
10	2	0	0	$\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$	4	5
9	3	$\frac{1}{2}$	$\frac{1}{2}$	1	2	3	5	7
8	4	1	1	$1\frac{1}{2}$	$2\frac{1}{2}$	5	...	...
7	5	$1\frac{1}{2}$	2	$2\frac{1}{2}$	5	...	...	...
6	6	2	3	5	...	...	...	...
5	7	5	5	...	...	...	...	...
4	8	6	...	...	...	...	...	...
		Dec.	Nov.	Oct.	Sept.	Aug.	July	June
			Jan.	Feb.	Mar.	Apr.	May	

For 40° N.; Northern United States, Armenia, Spain, Italy, Turkey, Japan, Greece, Pekin, and Central China.

A	P		May	Apr.	Mar.	Feb.	Jan.	
M	M	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	12	0	0	0	$\frac{1}{2}$	$\frac{1}{2}$	1	1
11	1	0	0	0	$\frac{1}{2}$	$\frac{1}{2}$	1	1
10	2	0	0	$\frac{1}{2}$	$\frac{1}{2}$	1	$1\frac{1}{2}$	$1\frac{1}{2}$
9	3	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	1	2	2
8	4	1	1	1	2	2	3	4
7	5	1	$1\frac{1}{2}$	3	4	5	5	5
6	6	2	3	4
5	7	5
		Dec.	Nov.	Oct.	Sept.	Aug.	July	June
			Jan.	Feb.	Mar.	Apr.	May	

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For 30° N.; Southern China, Southern United States, Northern Mexico, Northern Africa, Arabia, and Northern India.

A	P		May	Apr.	Mar.	Feb.	Jan.	
M	M	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	12	$\frac{1}{2}$	0	0	0	0	$\frac{1}{2}$	1
11	1	0	0	0	0	0	$\frac{1}{2}$	1
10	2	0	0	0	0	$\frac{1}{2}$	1	1
9	3	0	0	$\frac{1}{2}$	$\frac{1}{2}$	1	$1\frac{1}{2}$	2
8	4	$\frac{1}{2}$	1	$1\frac{1}{2}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3
7	5	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	4	5	...
6	6	3	4	6	...	...	...	...
		Dec.	Nov.	Oct.	Sept.	Aug.	July	June
			Jan.	Feb.	Mar.	Apr.	May	

For 30° S.; Southern Australia, Northern Argentina, Cape Colony, and Uruguay.

For 23° N.; India, Mexico, Southern Egypt, Central Arabia, Cuba, and Northern West Indies.

A	P		May	Apr.	Mar.	Feb.	Jan.	
M	M	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	12	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	0	0	0	$\frac{1}{2}$
11	1	0	0	0	0	0	$\frac{1}{2}$	$\frac{1}{2}$
10	2	0	0	0	0	$\frac{1}{2}$	$\frac{1}{2}$	1
9	3	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	1	1	$1\frac{1}{2}$
8	4	1	1	1	$1\frac{1}{2}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$
7	5	2	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	7
6	6	3	4	6	...	...	...	...
		Dec.	Nov.	Oct.	Sept.	Aug.	July	June
			Jan.	Feb.	Mar.	Apr.	May	

For 23° S.; Northern Australia, Northern Chile, Bolivia, Madagascar, Rio Janeiro, and Transvaal.

Tropics, 20° N. to 20° S.; Northern Brazil, Canal Zone, Central Africa, Ceylon, Borneo, Sumatra and Pacific Islands.

A	P		May	Apr.	Mar.	Feb.	Jan.	
M	M	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	12	0	0	— $\frac{1}{2}$	— $\frac{1}{2}$	— $\frac{1}{2}$	0	0
11	1	0	0	0	0	0	0	0
10	2	0	0	0	0	0	0	0
9	3	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1
8	4	1 $\frac{1}{2}$	1	1	1	1	1	1 $\frac{1}{2}$
7	5	3	3	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	3	3

PLATE SPEEDS.—The numbers in the first column indicate the exposure factors for use with the *American Photography Exposure Tables*. The letters in the last column are development speeds for Thermo Development. The other columns contain factors for use with the Burroughs-Wellcome, Watkins, Wynne and Harvey exposure meters.

	Amer. Phot.	B.W.	Wat.	Wynne	Har.	T.D.
Agfa film	1 $\frac{1}{2}$	1/6	130	73	E	M
Agfa Color plate						
AnSCO Speedex film	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	MS
A. P. M. Ultra speed	$\frac{1}{2}$	1/12	350	120		M
A. P. M. No Skrene	$\frac{3}{4}$	1/6	250	100		M
A. P. M. special rapid	1	1/6	180	87		M
A. P. M. film	1	$\frac{1}{8}$	180	87		M
A. Edwards Ensign	1	1/6	180	87		S
A. Edwards Ensign speedy	$\frac{3}{4}$	$\frac{1}{8}$	250	100		S
Barnet Ordinary	4	$\frac{1}{2}$	65	52		M
Barnet Special rapid	1 $\frac{1}{2}$	$\frac{1}{4}$	130	73		MS
Barnet self-screen	1	1/6	180	87		M
Barnet Red seal	$\frac{3}{4}$	$\frac{1}{8}$	250	100		MS
Barnet Studio 400	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	M
Barnet Studio 500 & Press	$\frac{1}{2}$	1/12	350	120	D	S
Barnet Ult. rap. & SS ortho	$\frac{1}{4}$	1/16	500	143	E	S
Barnet Studio 400 ortho	$\frac{3}{4}$	$\frac{1}{8}$	250	100	E	M
Barnet Press	$\frac{1}{2}$	1/12	350	120		VS
Bauchet B. P. A. D	$\frac{1}{2}$	1/12	350	120		S
Bauchet B. P. A. O	$\frac{3}{4}$	$\frac{1}{8}$	250	100		S
Bauchet B. P. A. B	1 $\frac{1}{2}$	1/3	130	73		MS
Bauchet B. P. A. A	3	1	65	52		MS
Carbine roll film	1	$\frac{1}{8}$	180	86		VS
Central Colornon	4	1	65	52	J	MQ
Central Pan. Ortho. Com	4	$\frac{1}{2}$	65	52	H	MQ
Central Comet	1 $\frac{1}{2}$	1/3	130	73	G	M
Central Special	1	1/6	180	86	E	VS
Central Special XX	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	VS

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	Amer. Phot.	B.W.	Wat.	Wynne	Har.	T.D.
Central Excelall	$\frac{1}{2}$	1/12	350	120	O	S
Cramer Contrast	9	3	32	35	M	VVQ
Cramer Slow Iso	5	1 $\frac{1}{2}$	130	73	K	MQ
Cramer Com. & Com. Iso	1 $\frac{1}{2}$	$\frac{1}{2}$	130	73	H	MQ
Cramer Spectrum & Trichrome ...	2	1/3	90	60	H	MQ
Cramer Anchor & med. Iso.	2	1/3	90	60	G.H	MQ
Cramer Banner X	1 $\frac{1}{2}$	1/6	130	73	F	S
Cramer Inst. Iso & Iso. Port.	1	1/6	180	86	E	MQ
Cramer Crown. Post	1	1/6	180	86	E	S
Cramer Speed-o-krome	1	1/6	180	86	E	S
Cramer Hi-Speed	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	S
Criterion Process	12	3	32	35	M	Q
Criterion Ordinary	4	$\frac{1}{2}$	65	52	H	Q
Criterion Iso ordinary	2	1/3	90	60	H	M
Criterion Extra rapid	2	1/3	90	60	H	MS
Criterion Extra rapid Iso	1 $\frac{1}{2}$	$\frac{1}{4}$	130	72	G	M
Criterion Roll film	1	1/6	180	87		VS
Criterion Cine film	1 $\frac{1}{2}$	$\frac{1}{4}$	130	72		MQ
Criterion Special Extra Rap.	1	1/6	180	87		VS
Criterion Portrait	1	1/6	180	87		MS
Criterion Enelite	$\frac{1}{2}$	1/12	350	120		VS
Eastman Process film	9	3	32	35	L	MQ
Eastman Cine Pos. film	9	3	32	35		MQ
Eastman Rapid plate	1 $\frac{1}{2}$	$\frac{1}{4}$	130	72		MS
Eastman Extra rapid plate	1	1/6	180	87		MS
Eastman Spl. ultra rapid	1	$\frac{1}{8}$	180	87		MS
Eastman ortho	1	$\frac{1}{8}$	180	87		MS
Eastman Super-sensitive plate ...	$\frac{1}{2}$	1/12	350	120		VS
Eastman Par-speed Port. Film ...	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	MS
Eastman Cine neg. ord.	1	1/6	180	87		S
Eastman Cine neg. sup. speed	$\frac{3}{4}$	$\frac{1}{8}$	250	100		VS
Eastman Cine neg. pan.	$\frac{1}{2}$	$\frac{1}{8}$	130	72		MS
Eastman Sup. Speed Port film	$\frac{1}{2}$	1/12	350	120	B	VS
Eastman Commercial	4	2/3	65	52	H	M
Eastman Commercial ortho	1	$\frac{1}{8}$	180	87	G	MQ
Gem Process	5	1 $\frac{1}{2}$	65	52	M	Q
Gem Universal Slow	4	1	32	35	M	MQ
Gem Universal	4	$\frac{1}{2}$	65	52	I	M
Gem Medium	2	$\frac{1}{4}$	90	60	H	S
Gem Tricol	1 $\frac{1}{2}$	$\frac{1}{4}$	130	87		Q
Gem Ultra rap. studio	1	1/6	180	87	F	S
Gem Noskrene & Sp. Rap.	1	1/6	180	87	F	S
Gem Meteor	1	1/6	180	87	F	M
Gem Iso	1	1/6	180	87	F	M
Gem Roll film	1	$\frac{1}{8}$	180	87		VS
Gem portrait & Salon Iso	$\frac{3}{4}$	$\frac{1}{8}$	250	87	E	S
Gem Gold label	$\frac{1}{2}$	1/12	350	120		S
Gem Salon XX & Iso	$\frac{1}{4}$	1/16	500	143	D	VS
Gem Salon Film	$\frac{3}{4}$	$\frac{1}{8}$	250	87		S
Gevaert Ortho Process	9	2	32	35	M	M
Gevaert Ordinary	4	2/3	65	52	I	MQ
Gevaert Ortho antihalo	1	$\frac{1}{4}$	180	87	E	MQ
Gevaert Filtered ortho	1 $\frac{1}{2}$	$\frac{1}{4}$	130	72	G	MS
Gevaert Spec. rapid	1	1/6	180	87	F	MQ
Gevaert Orthochrome	1	1/6	180	87	F	MQ
Gevaert Special sensitive	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	VS

EXPOSURE

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	Amer. Phot.	B.W.	Wat.	Wynne	Har.	T.D.
Gevaert Sensima	$\frac{1}{4}$	1/12	500	143	D	S
Gevaert Sensima ortho	$\frac{1}{4}$	1/12	500	143	E	M
Gevaert Cine film	2	$\frac{1}{4}$	90	60		MQ
Goerz Tenax Ultra rap	$\frac{3}{4}$	$\frac{1}{8}$	250	100		VS
Goerz Tenax Ultra Iso	$\frac{3}{4}$	$\frac{1}{8}$	250	100		S
Goerz Tenax Ex. rap.	$\frac{3}{4}$	$\frac{1}{8}$	250	100		MS
Goerz Tenax Ex. rap. Iso	1½	$\frac{1}{4}$	130	72		MS
Goerz Tenax Ex. Iso antihalo	1½	$\frac{1}{4}$	130	72		M
Goerz Tenax film	1½	$\frac{1}{4}$	130	72		MS
Graflex roll film	1	1/6	180	87		VS
Griffin Com. & Prof. 125	2	1/3	90	60		M
Griffin Com. & Prof. 250	1	1/6	180	87		MS
Griffin Com. & Prof. 375	$\frac{3}{4}$	$\frac{1}{8}$	250	100		VS
Griffin Self ortho	1	1/6	180	87		MS
Griffin Gramme	1	1/6	180	87		MS
Griffin Roll film	1	$\frac{1}{8}$	180	87		MS
Griffin Press	$\frac{3}{4}$	$\frac{1}{8}$	250	100		VS
Hammer Slow	4	1	65	52	J	VQ
Hammer Slow ortho	1½	1	130	72	J	VQ
Hammer Fast	1½	1	120	70		MQ
Hammer Ortho non-hal.	1½	1	120	70		M
Hammer Ortho extra fast	1½	$\frac{1}{4}$	130	72	D	M
Hammer Aurora extra fast	1½	$\frac{1}{4}$	130	72	E	MS
Hammer Postal & extra fast	1	1/6	180	87	E	M
Hammer Special extra fast	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	MS
Hauff ortho anti-hal	1½	1/3	120	70		M
Hauff Flavine	1½	$\frac{1}{4}$	130	72		M
Hauff Ext. rap. ortho	1½	1/6	130	72		MS
Hauff Ultra rapid	$\frac{1}{2}$	1/12	350	120		VS
Ilford Process	9	2	32	35	M	Q
Ilford Rap. Proc. Pan	2	1/3	90	73		VVQ
Ilford Half-tone	4½	1	65	52	I	Q
Ilford Ordinary	3	2/3	65	52	I	VQ
Ilford Empress	4	$\frac{1}{2}$	65	52	H	M
Ilford Empress film	2	1/3	90	63		VQ
Ilford Chromatic	1½	$\frac{1}{4}$	130	72		M
Ilford Special rapid	1	1/6	180	87		MS
Ilford Special rapid film	1	1/6	180	87		MS
Ilford Screened chromatic	1	1/6	180	87	G	MQ
Ilford Roll film	$\frac{3}{4}$	$\frac{1}{8}$	250	100		MS
Ilford Spec. rap. Pan.	$\frac{1}{2}$	$\frac{1}{8}$	350	120	F	Q
Ilford Auto-screen	$\frac{1}{2}$	$\frac{1}{8}$	350	120		M
Ilford Rapid chromatic	$\frac{3}{4}$	$\frac{1}{8}$	250	100		MQ
Ilford S. R. Ext. Sen.	$\frac{1}{2}$	1/12	350	120	E	MS
Ilford Zenith 400	$\frac{1}{2}$	1/12	350	120	E	MS
Ilford Zenith film	$\frac{3}{4}$	$\frac{1}{8}$	250	100		MS
Ilford Press	$\frac{1}{2}$	1/12	350	120	D	S
Ilford Monarch	$\frac{1}{2}$	1/12	350	120	D	S
Ilford Zenith 650	$\frac{1}{4}$	1/16	500	143	C	MS
Ilford Zenith Ex-Sen. film	$\frac{1}{2}$	1/12	350	120		VS
Ilford Iso Zenith	$\frac{1}{4}$	1/16	500	143		MS
Illingworth Ordinary	4	$\frac{1}{2}$	65	52	I	VQ
Illingworth Med. & Ortho med. ...	2	$\frac{1}{4}$	90	60	H.I	Q.VQ
Illingworth Pan. Process	4	1	65	52		VVQ
Illingworth Sp. rapid	1	1/6	180	87	G	MQ
Illingworth Non screen	1	1/6	180	87	G	VQ

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	Amer. Phot.	B.W.	Wat.	Wynne	Har.	T.D.
Illingworth roll film Pack	1	$\frac{1}{8}$	180	87		M
Illingworth Panchro fast	$\frac{3}{4}$	$\frac{1}{8}$	250	100	E	Q
Illingworth High rapidity	$\frac{3}{4}$	$\frac{1}{8}$	250	100	E	MQ
Illingworth Ultra rapid	$\frac{1}{2}$	$1/12$	350	120	E	MS
Illingworth Studio fast	$\frac{1}{2}$	$1/12$	350	120	E	VS
Illingworth Fleet	$\frac{1}{2}$	$1/12$	350	120	D	M
Illingworth Studio ex. fast	$\frac{1}{4}$	$1/16$	500	143	G	VS
Illingworth Super Fleet	$\frac{1}{4}$	$1/16$	500	143	D	S
Illingworth Ortho fast	$\frac{1}{2}$	$1/16$	350	120	E	M
Imperial Process	9	2	32	35	M	Q
Imperial Process Pan.	4	1	65	52	I	MQ
Imperial Landscape	6	$1\frac{1}{2}$	45	43		MQ
Imperial Fine grain Ord.	6	1	45	43	K	VVQ
Imperial Ord	4	$2/3$	65	52	I	VVQ
Imperial Sovereign	$1\frac{1}{2}$	$\frac{1}{4}$	130	72	A	Q
Imperial Spec. rap	1	$1/6$	180	87	F	Q
Imperial Spec. rap ortho	1	$1/6$	180	87	G	MQ
Imperial Non-filter	1	$1/6$	180	87	G	VVQ
Imperial Roll film	$\frac{3}{4}$	$\frac{1}{8}$	250	100	E	M
Imperial Panchro A	1	$\frac{1}{8}$	180	87	F	VVQ
Imperial Panchro B	$\frac{1}{2}$	$\frac{1}{8}$	350	120	F	VQ
Imperial Special sen.	$\frac{3}{4}$	$\frac{1}{8}$	250	100	F	M
Imperial Special sen. ortho	$\frac{3}{4}$	$\frac{1}{8}$	250	100	F	VQ
Imperial S. S. Press & Flashlight .	$\frac{1}{2}$	$1/12$	350	120	E	VS
Imperial S. S. S. Press	$\frac{1}{4}$	$1/16$	500	143		VS
Imperial Eclipse	$\frac{1}{4}$	$1/16$	500	143	C	S
Imperial Eclipse soft, ortho, ortho soft	$\frac{1}{4}$	$1/16$	500	143	C	MS
Jouglia Rose label & ortho A	1	$\frac{1}{4}$	180	87		M
Jouglia Intensive	1	$\frac{1}{4}$	180	87	F	VS
Jouglia Ortho B & C	1	$\frac{1}{4}$	180	87	G	M
Jouglia Pan. Process	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		M
Jouglia Blue band & Prof.	1	$1/6$	180	87		MS
Jouglia Green label	$\frac{3}{4}$	$\frac{1}{8}$	250	100		MS
Jouglia Mauve band	$\frac{1}{2}$	$1/12$	350	143		MS
Kodak Speed film	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	S
Kodak film pack	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	S
Kodak cut film reg.	$\frac{3}{4}$	$\frac{1}{8}$	250	100	D	S
Kodak super speed	$\frac{1}{2}$	$1/12$	350	120	B	VS
Lumière Blue label	$1\frac{1}{2}$	$\frac{1}{4}$	130	72	G	M
Lumière Simplex, anti-hal.	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		M
Lumière Ortho A. B.	1	$\frac{1}{4}$	180	87		Q
Lumière Ortho C	1	$\frac{1}{4}$	180	87		Q
Lumière Pan. Procédé	1	$\frac{1}{4}$	180	87		Q
Lumière Reproduction	2	$\frac{1}{4}$	90	60		MQ
Lumière Pelliculaire	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		MS
Lumière Instantanée	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		MQ
Lumière panchromatic	1	$1/6$	180	87		VQ
Lumière Extra rapide	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		MQ
Lumière Grande instantanée	1	$\frac{1}{4}$	180	87		MQ
Lumière Portrait instantanée	1	$\frac{1}{4}$	180	87		M
Lumière Maxima	$\frac{3}{4}$	$\frac{1}{8}$	250	100		M
Lumière Sigma	$\frac{1}{4}$	$1/16$	500	143	B	VS
Lumière Autochrome	$7\frac{1}{2}$ -8	$\frac{1}{2}$	8	15	Q	
Lumière Plavik film	$1\frac{1}{2}$	$\frac{1}{4}$	130	87		MQ
Lumière Cine film	$1\frac{1}{2}$	$\frac{1}{4}$	130	87		M
Lumière N. C. Speed film	1	$\frac{1}{8}$	250	100		S

	Amer. Phot.	B.W.	Wat.	Wynne	Har.	T.D.
Lumière Sigma ortho film	1	$\frac{1}{4}$	180	87		S
Marion Process	9	4	32	35		H
Marion Fine grain	6	2	45	43	M	Q
Marion Ordinary	4	$\frac{1}{2}$	45	43	I	MQ
Marion Panchro	$\frac{3}{4}$	$\frac{1}{2}$	250	100	F	MQ
Marion Inst. & Iso	1	$1/6$	180	87	G	M
Marion Brilliant	$\frac{3}{4}$	$\frac{1}{2}$	250	100	F	MS
Marion Record & Iso Record	$\frac{1}{4}$	$1/16$	500	143	O	VS.S
Marion P. S.	$\frac{3}{4}$	$\frac{1}{2}$	250	100		MS
Marion Portrait	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		M
Marion W. B.	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		MQ
Mawson Photomech.	9	4	32	35		Q
Mawson Castle	4	1	65	52	I	VS
Mawson Felixi	1	$1/6$	180	87	G	M
Mawson Gladiator	$\frac{3}{4}$	$\frac{1}{2}$	250	100	E	S
Mawson Ortho A & Pan.	$1\frac{1}{2}$	$\frac{1}{4}$	130	72	F.G	MS.VS
Mawson Wizard	$\frac{3}{4}$	$\frac{1}{2}$	250	100	E	MS
Mawson Victory	1	$\frac{1}{2}$	180	87	E	S
Mawson Super Gladiator	$\frac{1}{2}$	$1/12$	350	120		VS
New Record, ext. fast	$\frac{3}{4}$	$1/6$	250	100		M
Novex ext. speedy	$\frac{3}{4}$	$1/6$	250	100	F	S
Novex ortho	1	$1/6$	180	87	F	M
Novex ortho studio	$\frac{3}{4}$	$\frac{1}{2}$	250	100	E	MS
Novex Max. speed	$\frac{1}{2}$	$\frac{1}{2}$	350	120	D	S
Paget Color plate	5	4	11	21		
Paget XX	2	$\frac{1}{4}$	90	60		MS
Paget XXX	$1\frac{1}{2}$	$\frac{1}{4}$	130	72	H	MS
Paget process Pan.	2	$\frac{1}{4}$	90	60		M
Paget S. F. Ortho	$\frac{3}{4}$	$\frac{1}{2}$	250	100		S
Paget S. R. & Ortho S. R.	1	$1/6$	180	87	G	S
Paget Prof. Med.	1	$1/6$	180	87	E	S
Paget Ortho ext. Spec. rap.	$\frac{1}{2}$	$\frac{1}{2}$	350	120		VS
Paget Port. & extra S. R.	$\frac{1}{2}$	$1/12$	350	120	E	S
Paget Prof. ext. R.	$\frac{1}{2}$	$1/12$	350	120	E	VS
Paget roll film	1	$\frac{1}{2}$	180	87		VS
Paget S. F. ortho	1	$\frac{1}{2}$	250	100		MS
Paget Pan. ord.	$1\frac{1}{2}$	$\frac{1}{4}$	130	72		MS
Paget Hurricane	$\frac{1}{4}$	$1/16$	500	143	O	S
Rajar Ordinary	4	$\frac{1}{2}$	65	52	I	Q
Rajar S. R. & Iso N. S.	1	$1/6$	180	87	F	M
Rajar roll film	1	$\frac{1}{2}$	180	87	F	MS
Rajar Ultra rap. 400	$\frac{3}{4}$	$1/6$	250	100	E	M
Rajar Ultra rap. 550	$\frac{1}{2}$	$\frac{1}{2}$	350	120		M
Seed Process	9	3	32	35	L	Q
Seed Panchro	$1\frac{1}{2}$	1	130	72	J	MQ
Seed 23	$1\frac{1}{2}$	$\frac{1}{2}$	130	72	H	MQ
Seed Ortho L	$1\frac{1}{2}$	$1/6$	130	72	E	M
Seed 26x & Non-hal.	$\frac{3}{4}$	$1/6$	250	100	E	M
Seed Gilt Edge 30	$\frac{1}{2}$	$\frac{1}{2}$	350	120	D	MS
Seed Graflex	$\frac{1}{4}$	$1/12$	500	142	O	VS
Standard Imp. Port.	$\frac{3}{4}$	$\frac{1}{4}$	250	100		M
Standard Postcard	$\frac{3}{4}$	$\frac{1}{2}$	250	100	H	Q
Standard Orthonon & Poly.	$\frac{3}{4}$	$1/6$	250	100	E	M
Standard Ext. Imperial	$\frac{3}{4}$	$1/6$	250	100	E	MS
Stanley Commercial	4	$\frac{1}{2}$	65	52	H	Q
Stanley Regular	$\frac{3}{4}$	$1/6$	250	100	E	MS

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	Amer. Phot.	B.W.	Wat.	Wynne	Har.	T.D.
Vulcan film	1	1/6	180	86		VS
Wellington Film	1	1/8	180	86		M
Wellington Ortho Process	9	1	32	35	M	VVQ
Wellington Ordinary	4	1/2	90	60		Q
Wellington Speedy Portrait	1	1/6	180	86	G	M
Wellington Extra Speedy	3/4	1/8	250	100	F	M
Wellington Iso speedy & Anti-scr. .	1	1/6	180	86	F	M
Wellington Studio anti-screen	1/4	1/16	500	143	E	MS
Wellington Press & Spec. extra speed	1/2	1/12	350	120	F	S
Wellington Xtreme	1/2	1/12	350	120	E	S
Wellington super Xtreme	1/4	1/16	500	143	C	VS
Wratten Panchro.	1 1/2	1/8	130	72		MS
Wratten Panchro. Process	5	1/2	65	52		
Wratten Panchro. M	5	1/2	65	52		

Exposure.—The following table shows the exposure corresponding to the number found by adding the five factors.

$3\frac{1}{2}$ $\frac{S}{5000}$	4 $\frac{S}{4000}$	$4\frac{1}{2}$ $\frac{S}{2500}$	5 $\frac{S}{2000}$	$5\frac{1}{2}$ $\frac{S}{1250}$
6 $\frac{S}{1000}$	$6\frac{1}{2}$ $\frac{S}{700}$	7 $\frac{S}{500}$	$7\frac{1}{2}$ $\frac{S}{350}$	8 $\frac{S}{250}$
$8\frac{1}{2}$ $\frac{S}{150}$	9 $\frac{S}{100}$	$9\frac{1}{2}$ $\frac{S}{75}$	10 $\frac{S}{50}$	$10\frac{1}{2}$ $\frac{S}{40}$
11 $\frac{S}{25}$	$11\frac{1}{2}$ $\frac{S}{20}$	12 $\frac{S}{12}$	$12\frac{1}{2}$ $\frac{S}{10}$	13 $\frac{S}{8}$
$13\frac{1}{2}$ $\frac{S}{5}$	14 $\frac{S}{4}$	$14\frac{1}{2}$ $\frac{S}{3}$	15 $\frac{S}{2}$	$15\frac{1}{2}$ $\frac{S}{2\frac{2}{3}}$
16 $\frac{S}{1}$	$16\frac{1}{2}$ $\frac{S}{1\frac{1}{2}}$	17 $\frac{S}{2}$	$17\frac{1}{2}$ $\frac{S}{3}$	18 $\frac{S}{4}$
$18\frac{1}{2}$ $\frac{S}{5\frac{1}{2}}$	19 $\frac{S}{7\frac{1}{2}}$	$19\frac{1}{2}$ $\frac{S}{11}$	20 $\frac{S}{15}$	$20\frac{1}{2}$ $\frac{S}{23}$
21 $\frac{S}{30}$	$21\frac{1}{2}$ $\frac{S}{45}$	22 $\frac{M}{1}$	$22\frac{1}{2}$ $\frac{M}{1\frac{1}{2}}$	23 $\frac{M}{2}$
$23\frac{1}{2}$ $\frac{M}{3}$	24 $\frac{M}{4}$	$24\frac{1}{2}$ $\frac{M}{6}$	25 $\frac{M}{8}$	$25\frac{1}{2}$ $\frac{M}{12}$
26 $\frac{M}{15}$	$26\frac{1}{2}$ $\frac{M}{24}$	27 $\frac{M}{30}$	$27\frac{1}{2}$ $\frac{M}{45}$	28 $\frac{H}{1}$
$28\frac{1}{2}$ $\frac{H}{1\frac{1}{2}}$	29 $\frac{H}{2}$	$29\frac{1}{2}$ $\frac{H}{3}$	30 $\frac{H}{4}$	$30\frac{1}{2}$ $\frac{H}{6}$

CONTINENTAL PLATE SPEEDS.—In the following table the speeds given are those usually accepted on the continent of Europe and are “degrees Scheiner.” A few plates, other than those of German make, are also included. These degrees are compared with those of other speed marking systems in a table on another page.

Agfa Chromo	16.5
Agfa Chromo Isolar	12.5
Agfa Chromo Isorapid	17
Agfa Extra-rapid	17
Agfa Film pack	15.5
Agfa Roll film	15.5
Agfa Color Plate	15
Agfa Isolar	12.5
Agfa Isorapid	17
Agfa Orthochrom Isolar	12.5
Agfa Special	15.5
Anker	15.5
Apollo Elite	17
Apollo Elite Violet	20
Bayer Roll and film pack	15.5
Berolina Landscape	12.5
Berolina Orthomat.	14
Berolina Ultra-Record K	15.5
Berolina Ultra-Record W	17
Colonia, blue label	15.5
Colonia, yellow label ortho	14
Colonia, yellow label ortho antihal.	12.5
Colonia, red label	12.5
Eastman E. R. Plates	14
Eastman ortho	12.5
Eastman rapid	12.5
Eastman S. S.	17

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Eastman S. U. R.	15.5
Eastman Seed 26	12.5
Eastman Seed 27	14
Eastman Ortho	12.5
Effwee Color	14
Effwee Garantie	14
Effwee ortho. antihal.	14
Effwee Special	12.5
Effwee Ultra rapid	17
Eisenberger Extra Rapid	14
Eisenberger Color	14
Eisenberger Ortho antihal	14
Eisenberger Reform	12.5
Eisenberger Ultra rapid	17
Elko Ultrarapid	17
Elko Ultrarapid antihal.	14
Elko Ultrarapid ortho	15.5
Elko Ultrarapid ortho antihal.	14
Ensign Filmpack & Roll film	17
Errtee Yellow label	15.5
Errtee lilac label	17
Errtee white label	15.5
Glock Fidelitas	14
Glock Bona	14
Goerz roll film and film pack	15.5
Guilleminot Radio-brom	18.5
Guilleminot Radio-Eclair	20
Haake High speed portrait	17
Haake Normal	14.5
Haake landscape and Process	16
Haake Ortho	17
Hauff Extra rapid	17
Hauff Orthochrom extra rapid	17

Hauff Orthochrom antihal.	17
Hauff Flavin	15.5
Hauff Ultra-rapid	20.5
Hauff Rontgen	19
Hauff Transparency	5
Herlango Germania	12
Herlango Ultra	16
Herlango Ultra ortho & Antihal	15
Herlango Tizian	16
Herlango Ortho-Vigor antihal.	15
Herlango Luzo, orthochrom antihal	13
Herlango Lirot, orthochrom antihal	11
Herlango Process	2
Herlango Germania transparency	1
Herzka Chromodux	15.5
Herzka Extra-rapid	17
Herzka Jotha a rapid	15.5
Herzka Jotha b ortho	14
Herzka Jotha c ortho antihal	14
Herzka Normal	14
Herzka Pressoplan filmpack	17
Herzka Reform	11
Herzka Ultra rapid	18.5
Ica Ideal Extra rapid	14
Ica Ideal antihal	14
Ica Ideal ortho & antihal	14
Ica Lloyd	12.5
Ica Maximar	14
Ica National	12.5
Ica Volta-Extra rapid	17
Ica Volta-ortho	14
Ilford Anti-screen	17
Ilford Special rapid	17

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Ilford Versatile	18.5
Ilford Zenith	18.5
Imperial Flashlight	18.5
Imperial Ortho spec. sen	17
Imperial Ortho spec. rapid	15.5
Imperial Special sensitive	17
Jahr Sigurd ord, all sorts	15
Jahr Sigurd ext. all sorts	18
Jahr Blue seal	15
Jahr Blue seal ortho	15
Jahr Red label, A, B, C, D	16.5
Kirschten Reform red label	11
Kirschten Extra rapid yellow label	14.5
Kirschten Extra rapid antihal.	14.5
Kirschten Extra rapid orthochrom	14.5
Kirschten Ultra Rapid	18
Kraco Extra rapid	15.5
Kraco ortho	15.5
Kraco ortho antihal	12.5
Kranseder Reform	12
Kranseder ortho. moment	15.5
Kranseder ortho. slow	10.5
Kranseder Bromsilber extra rapid	17.5
Kranseder Bromsilber antihal	11.5
Kranseder Bromsilber extra rich	15.5
Kranseder Imperial	18.5
Kranseder Munchener Aerial	16
Leonar Green label	12.5
Leonar Lutar	9.5
Leonar Red label	14
Leonar ortho & antihal	12.5
Lainer Ala	15.5
Lainer Ala ortho	15.5

Lainer Ala ortho antihal	14
Lainer Extra rapid	17
Lainer orthoton & antihal.	15.5
Lainer ortho Ré antihal	12.5
Lainer Ré	12.5
Lomberg Adler	17
Lomberg Elochrom	14
Lomberg Elochrom antihal.	12.5
Lomberg Extra rapid	15.5
Lomberg Landscape & Repro.	9.5
Lomberg Pleinair	8
Matter, Extra rapid	17
Matter, high sensitive	15.5
Matter, ortho & antihal	14.5
Matter, ortho extra rapid	17
Mimosa Blue label	15.5
Mimosa ortho & antihal.	14
Mimosa film	15.5
Mimosa yellow label	12.5
Mimosa Ultra	17
Mono Cosmos	12.5
Mono double coated	15.5
Mono Extra rapid	17
Mono Imperial	11
Mono ortho antihal.	12.5
Mono Perfectol	14
Mono Ultra	18.5
N. P. G. Negative paper	10
Perutz Antihalo	14
Perutz Bromsilber	15.5
Perutz Perorto, red	14
Perutz Perorto, green	15.5
Perutz Persenso	17

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Perutz Perxanto	14
Perutz Silver eoside	12.5
Premo film pack	14
Premo film pack Speed	15.5
Sachs Extra rapid	15.5
Sachs Color	14
Sachs Antihalation	12.5
Sachs Antihalation Color	11
Schleussner Blue label	17
Schleussner Yellow label	12.5
Schleussner Yellow label Instantaneous	17
Schleussner Inalo	15.5
Schleussner Orthochrom	15.5
Schleussner Red label	18.5
Schleussner Viridin	17
Schleussner A inalo	17
Stock Extra rapid	17
Stock Ordinary	14
Talbot Errtee Special rapid	16.5
Talbot Errtee Ortho & antihal	15
Talbot Errtee Extra sensitive	16.5
Talbot Errtee Ultra rapid	20.5
Unger & Hoffmann Verax normal	17
Unger & Hoffman Kromal	17
Unger & Hoffman Verax rapid	20
Unger & Hoffman Verax rapid with Star	20.5
Unger & Hoffmann Verax Bromide	18
Unger & Hoffmann Verax Isokromid	18
Unger & Hoffmann Verax Transparency	7
Westendorp & Wehner Red	18.5
Westendorp & Wehner Green	14
Westendorp & Wehner Color	17

Wiphot Extra rapid	14
Wiphot Color & antihalo	14
Wiphot ortho antihalo	12.5
Wiphot Ultra	20

BROMIDE PAPER SPEEDS (BURROUGHS-WELLCOME).—

Austral Star	4
Austral Pearl Crayon	4
Barnet Ordinary, Platino-matt, Cream Crayon	1½
Barnet Tiger Tongue	2
Barnet Verona	6
Barnet Bromoil	6
Coralyte Rapid	6
Coralyte Ordinary	12
Criterion Enamel	2
Criterion Platino-matt, Rough	6
Cyko Enlarging	48
Empire Bromyta	2
Gem	10
Gevaert Normal	1
Gevaert Vigorous	4
Gevaert Partox	24
Griffin	2
Ilford (all varieties except as below)	3
Ilford Rapid Contrasty	2
Ilford Ordinary Surface	6
Illingworth	2
Imperial Platino-matt	1
Kentmere Ordinary	1
Kentmere F. C.	2
Kentmere K. K.	16
Kentmere K. Q.	64
Kodak Royal	1½
Kodak Rapid (Platino-matt, Permanent)	1½

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Kodak Contrast (Platino-matt, Permanent)	4
Kodak Slow	6
Kodak Nikko, Velvet	3
Kodak Kodura	24
Kosmos	3
Kosmos Vitegas	24
Lilywhite, Normal	8
Lilywhite, Rapid	1½
Lumière, A, C, F, L	5
Lumière, B	2
Marion	6
Montauk	2
Paget	1½
P. M. C.	6
Rajar	6
Standard Bromide & P. M. C.	2
Wellington	1½
Wellington B. B.	6
Gaslight papers	approximately 64

LANTERN PLATES.—

Austral	15
Barnet	6
Cramer Lantern, Transparency	3
Eastman	6
Empire	12
Gem Black	10
Hammer, Yellow label	3
Hammer, White label	2
Ilford Special	5
Imperial Special	4
Imperial Slow	8
Jougla Black	8
Leto	6

Lumière Transparency, Black	8
Lumière Warm	25
Magnet	10
Marion Chloro-bromide	4
Marion Vandyke	32
Marion Gelatino-chloride	32
Mawson	4
Paget Rapid	1½
Paget Slow	12
Paget Color Transparency	3
Rajar	10
Royal Standard Black	8
Seed	3
Standard Regular	3
Standard Slow	4
Wellington	1
Wratten	20

In these tables the paper or plate with a factor number of 6 requires twice the exposure of one with a factor of 3, under like conditions.

COMPARISON OF PLATE SPEEDS.—Unfortunately, no common agreement has been arrived at as to the marking of plate speeds, but the following table gives the usually accepted ratios between the various systems:

H. & D. Pyro-S.	Watkins	Wynne	B. W. & Co.	Warnerke	Scheiner	Eder-Hecht Grey wedge	Relative Exposure
5.4	8	17	8	8	c	...	100
7	10	20	...	9	b	...	80
9	13.5	23	6	9.5	a	...	65
11	16.5	25.5	4	10	1	43	50
14	21	29	...	10.5	2	46	40
17.5	26	32	3	11	3	49	30

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H. & D. Pyro-S.	Watkins	Wynne	B. W. & Co.	Warnerke	Scheiner	Eder-Hecht Grey wedge	Relative Exposure
23	34	37	2	12	4	52	23
28	42	40	...	13	5	54	17
38	52	48	1½	14	6	57	14
45	66	52	1	15	7	60	11
56	82	58	2/3	16	8	63	9
70	103	64	...	17	9	66	7
88	130	72	½	18	10	69	5.5
105	154	79	...	19	11	72	4
140	206	90	1/3	20	12	75	3.3
175	257	100	¼	21	13	78	2.6
228	335	115	...	22	14	80	2
280	410	128	1/6	23	15	84	1.6
350	575	144	1/8	24	16	88	1.3
455	670	164	...	25	17	92	1
560	825	180	1/12	26	18	95	.8
700	1030	204	...	27	19	98	.6
875	1280	228	...	28	20	100	.5

To convert Hurter & Driffeld into the Watkins system: Multiply the H. & D. numbers by 50 and divide by 34.

To convert Wynne into Watkins: Multiply the square root of Watkins numbers by 6.4.

To convert Wynne into H. & D.: Multiply the square root of Wynne's numbers by 7.7.

This table gives an approximation of the connection between the various systems of determining plate speeds. But absolute reliance can not be placed upon it as there is no standard system and plate manufacturers differ as to their use of the Hurter & Driffeld (H. & D.) method, therefore, these speeds, as advertised by various makers, are not comparable.

It should be recognized that the figures given are for use with particular exposure systems and will yield good well-exposed negatives. The character of the same may not agree with individual opinions, and in this case higher or lower numbers should be used until with a given developer the desired character of negative is obtained. All plates have more or less latitude and, therefore, considerable variation in exposure may be given and good negatives be still obtained.

EFFECT OF THE STOP APERTURE.—The relative exposures are as the squares of the aperture of the stops or diaphragms. For instance, if the exposure with stop $f:8$ is 5 seconds, with $f:16$ it is not twice as much, but 4 times; because, according to the above rule, $8^2 = 64$ and $16^2 = 256$. Therefore, the exposures are as 64:256, or as 1:4. This applies to all lenses irrespective of their focal lengths.

VARIATION OF F VALUES.—When copying and enlarging, the lens is not working at its equivalent focus, the actual working focus being more or less increased; therefore the values of the stops are altered. Mr. Alfred Watkins gives the following table which shows the necessary variation of the exposure due to the alteration of the f value of the stop:

Lantern slide making	Copying			Thin Neg.	Medium Neg.	Dense Neg.
				Black and White	Photograph	Coloured Object
15 times focus from lens				$\frac{1}{4}$	$\frac{1}{2}$	1
10 “ “ “ “				$\frac{1}{4}$	$\frac{5}{8}$	$1\frac{1}{4}$
$5\frac{1}{2}$ “ “ “ “				$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{2}$
$3\frac{1}{2}$ “ “ “ “				$\frac{1}{2}$	1	2
$2\frac{3}{4}$ “ “ “ “				$\frac{5}{8}$	$1\frac{1}{4}$	$2\frac{1}{2}$
$2\frac{1}{2}$ “ “ “ “				$\frac{3}{4}$	$1\frac{1}{2}$	3
2 “ “ “ “				1	2	4

(Copying same size)

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The numbers in the table are multipliers of the calculated exposure.

VARIATION OF ENLARGING EXPOSURES FROM THEORETICAL.—Mr. Watkins also gives the table for enlarging:

Enlarging

Diameters	Thin Neg.	Medium Neg.	Dense Neg.
Equal size	1	2	4
1½	1½	3	6
2	2¼	4½	9
2½	3	6	12
3	4	8	16
4	6¼	12½	25
5	9	18	36

These numbers are multipliers, as in the last table.

The numbers of diameters of enlargement are found by dividing the length of one side of the enlargement by the length of the same side of the negative.

THE EFFECT OF ALTITUDE ON EXPOSURE.—Variations in exposure due to variations in altitude, or distance above sea level, are negligible in ordinary work, that is to say, unless the altitude exceeds 5000 ft., when three-quarters of the calculated exposure should be given. Over 10,000 ft., half the regular time would be sufficient. This is for near objects. Panoramic views from mountain tops require panchromatic plates and special filters to cut out haze, as in aerial exposures.

SHUTTER SPEEDS FOR MOVING OBJECTS.—The following are approximately the slowest speeds of the shutter which will give a sharp image. The object is assumed to be 25 feet distant from the lens and to move diagonally across the field of the lens:

People walking in street scenes	1/10 sec.
Animals and people walking slowly	1/25 "
People walking three miles per hour	1/50 "

People walking four miles per hour	1/100	“
Vehicles at eight miles per hour	1/150	“
Vehicles at ten miles per hour	1/200	“
Vehicles at twelve miles per hour	1/250	“
Bicycle and horse races	1/500	“
High diving	1/600	“
Automobile and fast horse races	1/1000	“

If the object is at 50 feet distance, twice the exposure can be given; at 100 feet, four times as much. The longer the focus of the lens the shorter must be the exposure, and the more nearly the object moves at right angles to the axis of the lens, the shorter the exposure.

EXPOSURES FOR INTERIORS.—Cover the camera and head with the focussing cloth, and wait until the eyes are accustomed to the dull light. Stop down until detail can barely be seen in the deepest shadow in which full detail is required. Note the stop, and consult the following table for the exposure at $f:16$ of a plate or film classed as $1\frac{1}{2}$ A. P.:

Stop noted	Exposure at $f:16$
$f:8$	56 minutes
$f:11$	28 minutes
$f:16$	14 minutes
$f:22$	7 minutes
$f:32$	$3\frac{1}{2}$ minutes
$f:45$	$1\frac{3}{4}$ minutes
$f:64$	52 seconds

For other stops or plates, calculate from the known speeds, remembering that each step in plate speed represents 50 per cent, whereas each listed stop represents 100 per cent variation.

NIGHT PHOTOGRAPHY.—Exposure suggested for trial at $f:8$ with ortho plates of speed $1\frac{1}{2}$ A. P.:

Lighted show windows 1 minute

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Illuminated buildings	2 minutes
Open streets with arc lamps	3 minutes
Open streets with wet roadway or snow	2 minutes
Close street scenes	6 minutes
Close street with wet roadway or snow	4 minutes

STOP APERTURE SYSTEMS.—Various systems have been suggested from time to time for numbering the diaphragms or stops, but practically only two have survived. In the one, and the more general, the *F* or ratio system, the effective aperture is expressed as a fraction of the equivalent focus, thus as *F*:8, *F*/8 or *f*:8, which means that the aperture of the stop is one eighth of the equivalent focus. The other system is based on *f*:4 as unity, and the stops are merely numbered in fractions and multiples of this. The following table shows the relation of the two systems, the latter being known as the U. S. system, or the Uniform System numbers:

	U. S. No.		U. S. No.
<i>f</i> :1	1/16	<i>f</i> :12	9
<i>f</i> :1.414	1/8	<i>f</i> :16	16
<i>f</i> :2	1/4	<i>f</i> :22.62	32
<i>f</i> :2.828	1/2	<i>f</i> :28	49
<i>f</i> :3	0.562	<i>f</i> :32	64
<i>f</i> :4	1	<i>f</i> :36	81
<i>f</i> :5	1.56	<i>f</i> :40	100
<i>f</i> :5.656	2	<i>f</i> :45.25	128
<i>f</i> :6	2.25	<i>f</i> :56	196
<i>f</i> :7	3.06	<i>f</i> :64	256
<i>f</i> :8	4	<i>f</i> :70	306.25
<i>f</i> :9	5.06	<i>f</i> :80	400
<i>f</i> :10	6.25	<i>f</i> :90.5	512
<i>f</i> :11.31	8	<i>f</i> :100	625

Stolze proposed *f*:10 as unit, and Dallmeyer ($\frac{1}{3.16}$). The Paris Congress also adopted *f*:10 as the unit. Zeiss adopted

$f:100$ as unity, so that the larger stops were marked with the relative luminosity, which gave as a fraction the relative exposures; for instance, $f:6.3$ was 256, and the exposure compared to that for $f:100$ was $1/256$. All these systems have practically fallen into disuse in England and America, the ratio system alone being used.

EXPOSURE METERS.—The Watkins, Wynne, Imperial, and Beck meters are based on the measurement of the actinic power of the light by the darkening of a sensitive paper to a standard tint. Scales bearing the $f:x$ value of the diaphragm and speed of the plate are brought into coincidence, and the exposure is then read off against the time taken by the paper to darken.

These meters should be exposed to the light falling upon the shadiest part of the subject in which full detail is required. If there is no important shadow, test the direct sunlight. If there is any important shadow, face the meter to the sky and not to the sun, or use the shadow of the body.

To judge the matching of the tint, hold the meter at arm's length and observe through half-closed eyes, and note the time when the paper is neither lighter nor darker than the tint. An absolute match is not required.

MAKING PAPER FOR EXPOSURE METERS.—In order to make a paper suitable for these meters, bromide paper should be immersed in the darkroom for 5 minutes in a 2.5 to 5 per cent solution of potassium metabisulphite or sodium nitrite, rinsed and dried. The tint caused by the action of light varies with the paper; but a test should be made by burning 2 grains of magnesium ribbon, coiled into a spiral, at a distance of $4\frac{3}{4}$ inches. The tint thus obtained will correspond to the correct exposure for a plate of Watkins' speed 1 exposed at $f:8$, midday in June sunlight. The colour should be matched with water colour.

Development

FACTORIAL DEVELOPMENT (*Watkins*).—There is practically a fixed relation between the time of appearance of the image and the total time of development to obtain a given density, degree of contrast, or gamma of a negative, which holds good for all variations of strength, amount of alkali, bromide, or temperature, within reasonable limits. This is known as the factorial or time development method. The total time of development divided by the “time of appearance” of the first signs of the image, exclusive of the sky in landscape work, or a white collar in a portrait, gives what is known as the “factor” of the developer. The following table gives the factors for various developers for a normal negative :

Adurol	5	Kodak portrait	18
Amidol	10	Metol	30
Azol	30	Metol-hydrochinon	14
Certinal	30	Ortol	10
Diogen	12	Paramidophenol	16
Edinol	20	Pyrocatechin	10
Eikonogen	9	Pyro-metol	9
Glycin-potash	12	Metoquinone	30
Glycin-soda	8	Rodinal	30
Hydrochinon with bromide	5	Synthol	30
Imogen-sulphite	6		

The following are the factors for pyro-soda or pyro-potash :

Pyro gr. per oz.	Bromide gr. per oz.	Factor	Pyro gr. per oz.	Bromide	Factor
1	$\frac{1}{4}$	9	1	0	18
2	$\frac{1}{2}$	5	2	0	12
3	$\frac{3}{4}$	$4\frac{1}{2}$	3	0	10
4	1	4	4	0	8
8	2	$3\frac{1}{4}$	5	0	$6\frac{1}{2}$

Estimated factors for American pyro-soda developers:

Seed A. B. C., no bromide	11
Seed pyro, no bromide	11
Stanley, no bromide	10
Cramer, maximum strength	$6\frac{1}{2}$
Cramer, minimum strength	11
Hammer, no bromide	11
Eastman, no bromide	12

Should the negatives obtained by the use of the above factors seem too thin, the factors must be increased; if the negatives are too dense, the factors should be decreased. The factor for a combined developer with the reducing agents in equal ratios is the mean of the two; for instance:

$$(\text{Pyro} = 6 + \text{metol} = 30) \div 2 = 18$$

If the developing agents are in different ratios, the factor for each is multiplied by the number of parts, and the sum of the factors divided by the number of parts of developer agents used. For instance, pyro 4 parts plus metol 2 parts:

$$6 \times 4 = 24 \text{ and } 30 \times 2 = 60$$

$$24 + 60 = 84 \text{ and } 4 + 2 = 6$$

then $84 \div 6 = 14$ the factor required.

THERMO-DEVELOPMENT (*Watkins*).—While the normal temperature for development is assumed to be 18° C. (65° F.), it is not always convenient or possible to obtain this temperature exactly, and, as the rapidity of development is increased with a rise of temperature, and decreased with a colder solution, allowance must be made for the change of

temperature. The variation in time of development due to changes in temperature of the solutions is known as the "temperature co-efficient," and is calculated for 10° C. (18° F.). In practice it will be found convenient to draw up a table for a developer for every 2 degrees rise or fall, which is not a difficult matter, as one can use the developer factor and a table of logarithms. Expose a plate on a landscape, including a portion of the sky, and cut into two, or make two exposures. It is necessary to have means for warming up the dish, developer and graduate, and also a thermometer must be handy. The warming apparatus need be nothing elaborate, a deep baking tin or a large developing dish. Fill this with water at about 32° C. (90° F.), and place the dish, graduate and developer in it. As soon as the developer has reached the desired temperature, which for convenience may be 24° C. (75° F.), and should not be above 27° C. (80° F.), place the plate in the dish, flood with the developer, and note the time; watch carefully for the first appearance of the image, and again note the time. The plate is no longer any use and may be thrown away. It is really advisable to place the plate in the dish at the same time as this is floated on the warm water, so that the plate itself may be raised in temperature. It can be easily covered with an opaque card to protect it from light. Then treat the second plate in the same way, only this time use the developer cold, and note the time of appearance exactly as before. If the difference in the temperatures of the two developers is exactly 10° C., the temperature co-efficient is found at once by subtracting the logarithm of the lesser time of appearance from the logarithm of the greater time. Should there be a greater or less difference in the temperatures than 10 degrees, subtract the logarithm of the lesser time from that of the greater time, and divide by the difference of temperatures. The result will be the log. factor

by which a table can be drawn up for the developer used. An example will make this clear. Suppose that we have a developer which we know from practical trial gives just the negative which we want with a factor of 10. Suppose that we make the above-described trial with a developer at 90° C. (48° F.) and 20° C. (68° F.), and with the lower temperature it took 50 seconds for the first appearance of the image, and at the higher temperature 22 seconds; then from a table of logarithms we find that the log. of 50 is 1.699 and that for 22 is 1.342, then:

$$\log. 50 = 1.699$$

$$\log. 22 = 1.342$$

$$0.357$$

Now the difference between the two temperatures was $20 - 9 = 11$, therefore $0.357 \div 11 = 0.0324$, which is the logarithm of the difference in time of development for 1° C. or the log. factor. As we know that the developer has a factor of 10, therefore, if the time of appearance at 9° C. was 50 seconds, the total time of development will be $50 \times 10 = 500$ seconds. Then, if we want to find the time of development for 10° C., we subtract the log. factor 0.0324 from the log. of 50, and multiply by the factor to find the correct time of development. Thus $\log. \text{ of } 50 = 1.699 - 0.0324 = 1.6666$; from a table of logs. we find that this is the log. of 46.4, and, multiplying by the factor 10, we have 464 seconds as the result, instead of 500 at 9 degrees. If the temperature is lower, then we add the log. factor; thus, assuming that the temperature has dropped 2 degrees to 7° C., then $\log. 50 = 1.699 + (0.0324 \times 2) = 1.699 + 0.0688 = 1.7638$; from our table we find this to be the log. of 58.05, and again, using our factor, we have $58.05 \times 10 = 580.5$ seconds as the correct duration of development at the lower temperature. The

following are a few temperature co-efficients that have been determined (Watkins):

Pyro-soda, without bromide (Watkins)	1.5
Pyro-soda, with bromide (Watkins)	1.9
Pyro-soda (H. & D.) without bromide	1.48
Pyro-soda, Kodak powders	1.9
Pyro-soda tabloid (B. & W.)	2.15
Pyro-soda tabloid, Ilford formula	2.04
Rodinal, Azol, Victol, Certinal	1.9
Metol-hydrochinon	1.9
Metol-hydrochinon tabloid	1.86
Glycin	2.3
Rytol	1.84
Hydrochinon	2.25
Paramidophenol	2.4
Amidol	2.06
Ortol	2.06

STAND DEVELOPMENT.—This is a method of development in which a dilute developer is used in an upright grooved tank, in which the plates are placed and left for a given time. In the early days, it was put forward as a cure for every error in exposure, and the solutions used were so dilute that from 12 to 24 hours were required to obtain normal negatives. The only advantages of stand development are that the grain of the negatives is fine and the results uniform, if the developer be frequently agitated, and no visual examination is required or possible. It has been stated that the duration of development with the diluted solutions can be calculated from their dilution, that is to say, a developer that is diluted 5 times will require 5 times as long in the tank, but this is only true of one or two developers. Wratten & Wainwright found by careful photometric measurements, that the increase in time depends to a great extent on the quantity of air dissolved in

the water used. In the case of rodinal it was found that a plate which required 3 minutes development with a 1:20 solution, when the latter was diluted to 1:200, did not require 30 minutes, but 42, with air-free distilled water; with ordinary distilled water 46 minutes, and with tap water 52 minutes. Pyro-soda and glycin seem to be the only developers that are not affected by the water, but a pyro developer diluted ten times requires fifteen times normal to obtain the same results. Stand development is not economical, as most commercial tanks require a large amount of solution, which is, as a rule, so oxidised at the end of development as to be useless for a second time. The following are some of the developers recommended for this method.

Pyro-soda (Wratten & Wainwright).—

A. Sodium sulphite, dry	5 g	3 oz.
Pyrogallol	1.66 g	1 oz.
Sulphuric acid	0.21 ccm	1 dr.
Water	1000 ccm	600 oz.
B. Sodium carbonate, cryst.	10 g	6 oz.
Water	1000 ccm	600 oz.

Mix in equal parts.

Glycin (Wratten & Wainwright).—

Glycin	0.833 g	½ oz.
Sodium sulphite, dry	1.25 g	¾ oz.
Potassium carbonate	4.16 g	2½ oz.
Water	1000 ccm	600 oz.

Glycin (Bothamley).—

Glycin	3 g	46 gr.
Sodium sulphite, dry	1.5 g	23 gr.
Water	2000 ccm	70 oz.

Time 1 hour at 18° C. (65° F.).

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Pyrocatechin (Bothamley).—

A. Pyrocatechin	10 g	154 gr.
Sodium sulphite, dry	40 g	616 gr.
Water	500 ccm	17½ oz.
B. Sodium carbonate, cryst.	100 g	3½ oz.
Water	500 ccm	17½ oz.

Time, 1 hour at 18° C. (65° F.).

Pyro-soda (Claudy).—

Sodium sulphite	3.9 g	90 gr.
Sodium carbonate	2.6 g	60 gr.
Pyro	1.3 g	30 gr.
Water	1000 ccm	48 oz.

Pyro-soda (Harris).—

Pyro	1 g	20 gr.
Sodium sulphite, dry	3 g	60 gr.
Sodium carbonate, cryst.	12 g	240 gr.
Potassium metabisulphite	6.5 g	130 gr.
Water	1000 ccm	40 oz.

Time, 10 to 15 minutes at 16° C. (60° F.).

Pyro-soda (Munkman).—

A. Pyro	100 g	1 oz.
Potassium metabisulphite	25 g	¼ oz.
Water	1000 ccm	10 oz.
B. Sodium sulphite, dry	100 g	1 oz.
Sodium carbonate, cryst.	100 g	1 oz.
Water	2000 ccm	20 oz.

For use, mix 1 part A, 1 part B and 8 parts water. Time: 25 minutes at 18° to 21° C. (65° to 70° F.); 30 minutes at 15° to 18° C. (60° to 65° F.); 40 minutes at 13° to 15° C. (55° to 60° F.); 50 minutes at 10° to 13° C. (50° to 55° F.). If the developer be used at half the above strength, the times will be: 50 minutes, 1 hour, 80 minutes, and 100 minutes respectively for the above temperatures.

Rodinal (Munkman).—Dilution 1 : 100. Sodium sulphite, dry, in $2\frac{1}{2}$ per cent solution may be used instead of water to dilute the developer :

Temperature		Development in minutes		
Cent.	Fahr.	Portrait	Architecture	Landscape
22°	72°	14	19½	27⅙
21	70	15	20½	28 2/3
20	68	16	21½	30
19	66	17	22½	31 1/3
18	64	18	23½	32 2/3
17	62	19	24½	34
15.5	60	20	25½	35 1/3
14.5	58	21	26½	36 2/3
13.5	56	22	27½	38
12.5	54	23	28½	39 1/3

Metol-glycin (Jeffcott).—

Metol	0.88 g	40 gr.
Glycin	0.44 g	20 gr.
Sodium sulphite, dry	1.6 g	75 gr.
Potassium carbonate	6.5 g	300 gr.
Hot water	1000 ccm	96 oz.

Adurol (Mortimer).—

Sodium sulphite, dry	200 g	4 oz.
Potassium carbonate	300 g	6 oz.
Water	1000 ccm	20 oz.

When dissolved add :

Adurol	50 g	1 oz.
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Dilute 1 : 20 ; time, 10 minutes at 18° C. (65° F.).

Edinol.—

Edinol	4.5 g	45 gr.
Sodium sulphite, dry	22 g	½ oz.
Potassium carbonate	44 g	1 oz.
Water	1000 ccm	20 oz.

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Edinol-Hydrochinon.—

Edinol	5 g	76 gr.
Hydrochinon	5 g	76 gr.
Sodium sulphite, dry	125 g	1842 gr.
Potassium carbonate	20 g	307 gr.
Sodium carbonate, cryst.	20 g	307 gr.
Caustic soda	4 g	61 gr.
Potassium bromide	1 g	15 gr.
Water	1000 ccm	32 oz.

Pyro for lantern slides (Mortimer).—

Pyrogallol	2.2 g	44 gr.
Sodium sulphite, dry	3.25 g	66 gr.
Sulphuric acid	0.5 ccm	10 min.
Acetone	1.2 ccm	24 min.
Water	1000 ccm	42 oz.

Time, 5 to 10 minutes at 18° C. (65° F.).

Amidol (Harris).—

Sodium sulphite, dry	13 g	250 gr.
Potassium metabisulphite	5.2 g	100 gr.
Potassium bromide	0.52 g	10 gr.
Amidol	2.6 g	50 gr.
Water	1000 ccm	40 oz.

Or:

Amidol	1 g	15 gr.
Sodium sulphite, dry	6 g	90 gr.
Caustic soda lye, 27%	10 ccm	145 min.
Potassium bromide	0.5 g	7.5 gr.
Water	1000 ccm	32 oz.

Time, 2 to 3 hours.

Glycin.—

Glycin	2 g	30.7 gr.
Sodium sulphite, dry	5 g	76.8 gr.
Potassium carbonate	10 g	153.8 gr.

Potassium bromide	0.05 g	0.768 gr.
Water	1000 ccm	32 oz.

COMBINED DEVELOPING AND FIXING.—This process frequently crops up and numerous formulas have been given for its use. The following are arranged in chronological order and the later ones do give some sort of satisfactory negatives.

Punnett.—

A. Potassium metabisulphite	2 g	35 gr.
Ortol	3 g	52.5 gr.
Water	400 ccm	10 oz.
B. Caustic soda	4 g	60 gr.
Potassium bromide	4 g	60 gr.
Water	500 ccm	16 oz.
C. Hypo	25 g	1 oz.
Water	500 ccm	20 oz.

For use mix 1 part A, 1 part B, and 2 parts water.

Hanneke.—

A. Sodium sulphite, dry	200 g	1536 gr.
Caustic potash	93 g	714 gr.
Pyrocatechin	93 g	714 gr.
Water	1000 ccm	16 oz.
B. Hypo	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.

For use mix 12 parts A, 20 parts B, and 30 parts water.

Baker.—

Hydrochinon	7.5 g	57.5 gr.
Potassium metabisulphite	15 g	115 gr.
Caustic potash	50 g	384 gr.
Hypo	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.

Or:

Edinol	7.5 g	57.5 gr.
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Sodium carbonate, cryst.	50 g	384 gr.
Sodium sulphite, dry	25 g	192 gr.
Hypo	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.

Or:

Hypo	30 g	230 gr.
Potassium metabisulphite	40 g	307 gr.
Sodium carbonate, cryst.	120 g	920 gr.
Potassium bromide	1 g	7.7 gr.
Water	1000 ccm	16 oz.

Add 2 per cent edinol just before use.

Pigg.—

Pyrogallol	1.5 g	11.5 gr.
Amidol	1.5 g	11.5 gr.
Sodium sulphite, sat. sol.	240 ccm	4 oz.
Sodium carbonate, sat. sol.	480 ccm	8 oz.
Potassium cyanide, sat. sol.	240 ccm	4 oz.

Crémier.—

Amidol	10 g	77 gr.
Sodium sulphite, dry	50 g	384 gr.
Hypo	125 g	2 oz.
Water	1000 ccm	16 oz.

Raymond.—

Hydrochinon	8 g	61 gr.
Metol	4 g	30.7 gr.
Sodium sulphite, dry	30 g	230 gr.
Sodium carbonate, cryst.	80 g	614 gr.
Hypo	6 g	46 gr.
Water	1000 ccm	16 oz.

Crémier, for lantern slide work.—

Sodium sulphite, dry	15 g	115 gr.
Hydrochinon	2.5 g	19.2 gr.
Caustic soda	1.5 g	11.5 gr.

Potassium bromide	1.5 g	11.5 gr.
Water	1000 ccm	16 oz.

The actual developer is 4 parts of the above, 8 parts water, and $2\frac{1}{2}$ parts of 20 per cent solution of hypo.

Haysede.—

Sodium sulphite, dry	20 g	154 gr.
Hypo	320 g	2457 gr.
Sodium carbonate, cryst.	10 g	77 gr.
Potassium bromide	10 g	77 gr.
Hydrochinon	25 g	192 gr.
Ammonia, 28% sol.	10 ccm	77 min.
Water	1000 ccm	16 oz.

E. W.—

Hydrochinon	12.5 g	96 gr.
Sodium sulphite, dry	50 g	384 gr.
Sodium carbonate, cryst.	100 g	770 gr.
Hypo	200 g	3 $\frac{1}{5}$ oz.
Ammonia	50 ccm	384 min.
Water	1000 ccm	16 oz.

Otsuki & Sudzuki.—

A. Metoquinone	6 g	36 gr.
Sodium sulphite, dry	30 g	180 gr.
Water	600 ccm	12 oz.
B. Hypo	60 g	576 gr.
Caustic soda	5 g	48 gr.
Water	400 ccm	8 oz.

Mix in equal volumes just before use.

Bunel.—

Amidol	5 g	38.5 gr.
Sodium sulphite, dry	30 g	230 gr.
Acetone	80 ccm	614 min.
Hypo	50 g	385 gr.
Water	1000 ccm	16 oz.

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Namias.—

Metol	1.5 g	11.5 gr.
Sodium sulphite, dry	30 g	230 gr.
Hydrochinon	4.5 g	34 gr.
Caustic soda	5 g	38.5 gr.
Hypo	60 g	460 gr.
Water	1000 ccm	16 oz.

DEVELOPERS FOR DEEP TANKS FOR COMMERCIAL FINISH-
ERS.—*Eastman Kodak Tank A B C Pyro formulas:*

A. Sodium bisulphite	9 g	140 gr.
Or potassium metabisulphite	9 g	140 gr.
Pyrogallol	60 g	2 oz.
Potassium bromide	1 g	16 gr.
Water to	1000 ccm	32 oz.
B. Sodium sulphite, dry	105 g	3½ oz.
Water to	1000 ccm	32 oz.
C. Sodium carbonate, dry	75 g	2½ oz.
Water to	1000 ccm	32 oz.

Take 5½ oz. each of A, B and C and add water to make one gallon (162 ccm to make 3785 ccm). Time of development about 12 minutes at 65° F. (18° C.). Portrait Super Speed film requires about 10 to 15 per cent longer development than other film.

Metol-Pyro tank developer:

A. Sodium bisulphite	7.5 g	¼ oz.
Metol	7.5 g	¼ oz.
Pyrogallol	30 g	1 oz.
Potassium bromide	2 g	60 gr.
Water to	1000 ccm	32 oz.
B. Sodium sulphite, dry	150 g	5 oz.
Water to	1000 ccm	32 oz.
C. Sodium carbonate, dry	75 g	2½ oz.
Water to	1000 ccm	32 oz.

Take 8 oz. each of A, B and C and add water to make one gallon (237 ccm to 3785 ccm). Time of development at 65° F. (18° C.) from 9 to 12 minutes. This developer can be repeatedly used if kept up to its normal strength. For strengthening use 2 oz. each of A, B and C to each 8 oz. of water (59 ccm to 237 ccm).

Metol-Hydrochinon tank developer:

Warm water	4000 ccm	1 gal.
Metol	12 g	170 gr.
Sodium sulphite, dry	360 g	12 oz.
Sodium bisulphite	7.5 g	¼ oz.
Hydrochinon	22.5 g	¾ oz.
Sodium carbonate, dry	45 g	1½ oz.
Potassium bromide	6 g	95 gr.
Cold water to	16 liters	4 gal.

Time of development at 65° F. (18° C.) from 10 to 14 minutes.

Strengthening solution:

Water	4000 ccm	1 gal.
Metol	6 g	85 gr.
Sodium sulphite, dry	180 g	6 oz.
Sodium bisulphite	3.5 g	55 gr.
Hydrochinon	12 g	170 gr.
Potassium bromide	2 g	45 gr.
Water to	8000 ccm	2 gal.

To give this stock solution greater keeping quality, the sodium carbonate should not be added until the strengthening solution is used. For use dissolve ½ oz. sodium carbonate in 16 oz. of the above solution (15 g in 473 ccm), and add to the tank

Tank developer for Ansco Speedex roll film:

	1 gal. tank	10-gal. tank
A. Warm water	32 oz.	2 gal.
Metol	22 gr.	½ oz.

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Sodium sulphite, dry	$\frac{3}{4}$ oz.	$7\frac{1}{2}$ oz.
Hydrochinon	90 gr.	2 oz.
Sodium bisulphite	$\frac{1}{2}$ oz.	5 oz.
Potassium bromide	5 gr.	50 gr.
Sodium carbonate, dry	1 oz.	10 oz.
Cold water to	$2\frac{1}{2}$ qt.	$9\frac{1}{2}$ gal.
B. Cold water	16 oz.	$\frac{1}{2}$ gal.
Pyrogallol	45 gr.	1 oz.

Add B to A and develop 15 to 20 minutes at 65° F., according to density desired. For each degree below 65° F., one minute should be added to the time of development chosen. For each degree above 65° F., one minute should be subtracted from the chosen development time, provided the bath is fairly fresh.

Renewer:

Water	32 oz.	2 gal.
Metol	22 gr.	$\frac{1}{2}$ oz.
Sodium sulphite, dry	$\frac{2}{5}$ oz.	4 oz.
Hydrochinon	45 gr.	1 oz.
Sodium bisulphite	$\frac{1}{4}$ oz.	$2\frac{1}{2}$ oz.
Sodium carbonate, dry	$\frac{2}{5}$ oz.	4 oz.

The renewer is added from time to time to keep the developer even with the top of the tank and at the same time to freshen up the solution. A fresh bath should, however, be mixed up every two or three weeks at least, according to the number of rolls developed in the old solution.

Developers

ACROL.—The Eastman name for amidol, which see.

ADUROL.—This is either bromhydrochinon (Schering) or chlorhydrochinon (Hauff), gives softer negatives than hydrochinon, and is less affected by temperature:

A. Sodium sulphite, dry	125 g	2 oz.
Adurol	16.6 g	128 gr.
Water	1000 ccm	16 oz.
B. Sodium carbonate, cryst.	350 g	5¾ oz.
Water	1000 ccm	16 oz.

Mix 3 parts A with 2 parts B.

A. Adurol	20 g	154 gr.
Potassium metabisulphite	20 g	154 gr.
Water	1000 ccm	16 oz.
B. Caustic soda	75 g	576 gr.
Potassium bromide	2 g	15 gr.
Water	1000 ccm	16 oz.

Mix in equal volumes.

A. Adurol	20 g	154 gr.
Sodium sulphite, dry	80 g	615 gr.
Water	1000 ccm	16 oz.
B. Potassium carbonate	125 g	2 oz.
Water	1000 ccm	16 oz.

For studio and instantaneous work mix in equal volumes.

For time exposures and landscape work mix equal volumes

A, B, and water.

AMIDOL.—A stable amidol developer (Namias):

Sodium sulphite, dry	25 g	192 gr.
Amidol	5 g	38½ gr.

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Metol	1 g	7.7 gr.
Potassium bromide	2 g	15.4 gr.
Water	1000 ccm	16 oz.

The metol exerts a protective action for the amidol.

Desalme has suggested as a preservative stannous tartrate, which is made as follows:

Stannous chloride	50 g	384 gr.
Tartaric acid	70 g	538 gr.
Boiling water	350 ccm	5½ oz.

To this add the following solution:

Sodium carbonate, dry	55 g	422 gr.
Warm water	300 ccm	5 oz.

Filter the mixture and make up to 1000 ccm (16 oz.). Make the amidol developer stock as follows:

Amidol	15 g	115 gr.
Sodium sulphite, dry	55 g	422 gr.
Stannous tartrate, as above	100 ccm	768 min.
Water	1000 ccm	16 oz.

For use dilute with 2 parts of water and add 3 per cent of sodium bisulphite lye. This stannous tartrate solution may also be successfully used with other developing agents. Another method of making the stannous tartrate solution is as follows:

Stannous chloride	10 g	77 gr.
Tartaric acid	15 g	115 gr.
Water	50 ccm	1 oz.

And add:

Sodium carbonate	25 g	192 gr.
Water	250 ccm	5 oz.

Filter and make up the bulk to 1000 ccm (16 oz.).

Glycollic and lactic acids have also been recommended as preservatives and act well:

Sodium sulphite, dry	31.25 g	½ oz.
Amidol	6.3 g	48 gr.
Potassium bromide	1.4 g	10 gr.
Glycollic acid	1.4 ccm	10 min.
Water	1000 ccm	16 oz.

Or:

Sodium sulphite, dry	30 g	230 gr.
Amidol	5 g	38.5 gr.
Lactic acid	5 ccm	40 min.
Water	1000 ccm	16 oz.

Alkaline amidol (Valenta).

Sodium sulphite, dry	15 g	115 gr.
Amidol	5 g	38½ gr.
Caustic soda	1 g	7.7 gr.
Water	1000 ccm	16 oz.

This keeps quite clear during development and does not stain.

Amidol is sold by the Eastman Kodak Co. under the name Acrol.

AMIDOL-PYRO.—The following is recommended as having all the good properties of amidol and yet giving an image of the same colour as pyro:

Potassium metabisulphite	1 g	8 gr.
Sodium sulphite, dry	42 g	336 gr.
Amidol	5 g	40 gr.
Pyrogallol	2 g	16 gr.
Potassium bromide	1 g	8 gr.
Water	1000 ccm	16 oz.

To this is added just before use:

Caustic soda	1 g	8 gr.
Water	1000 ccm	16 oz.

This can be used for plates and papers without staining. The Watkins factor is 10.

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DIAGEN.—Generally used in one solution:

Sodium sulphite, dry	150 g	2 oz., 372 gr.
Diogen	75 g	1 oz., 196 gr.
Potassium carbonate	375 g	6 oz.
Water	1000 ccm	16 oz.

Mix 1 part with 4 parts water.

EDINOL.—One solution:

Potassium metabisulphite	300 g	4 oz., 384 gr.
Water	500 ccm	8 oz.

Dissolve and add:

Edinol	100 g	1 oz., 318 gr.
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Then add:

Caustic potash	220 g	3 oz., 249 gr.
Water	1000 ccm	16 oz.

Mix 1 part with 10 to 20 parts water.

One solution with carbonate:

Sodium sulphite, dry	50 g	384 gr.
Edinol	50 g	384 gr.
Sodium carbonate, dry	12.5 g	96 gr.
Water	1000 ccm	16 oz.

Mix 1 part with 5 to 10 parts water. The sodium carbonate may be replaced by potassium carbonate 15 g (115 gr.), when the developer acts more rapidly. Gives very clean negatives.

Two solution:

A. Edinol	10 g	77 gr.
Sodium sulphite, dry	100 g	770 gr.
Water	1000 ccm	16 oz.
B. Sodium carbonate, dry	5 per cent solution	
or Potassium carbonate	5 per cent solution	

Mix in equal volumes. The potash works more rapidly and gives denser negatives.

Stock solution for Hammer Plates:

Sodium sulphite	125 g	2½ oz.
Edinol	10 g	96 gr.
Sodium carbonate	50 g	1 oz.
Water	1000 ccm	20 oz.

For use mix with an equal volume of water.

EIKONOGEN.—A slow acting soft developer:

A. Sodium sulphite, dry	67 g	514 gr.
Eikonogen	16.6 g	128 gr.
Water	1000 ccm	16 oz.
B. Sodium carbonate, dry	75 g	576 gr.
Water	1000 ccm	16 oz.

Mix 3 parts A with 1 part B. A more rapid acting developer can be made by replacing the soda by an equivalent weight of potassium carbonate, namely 98 g (752 gr.).

One solution:

Sodium sulphite, dry	60 g	460 gr.
Potassium carbonate	50 g	384 gr.
Eikonogen	30 g	230 gr.
Boiling water	1000 ccm	16 oz.

Keeps well. For use mix with an equal volume of water.

ELON.—Another name for Metol, under which heading the Eastman Elon formulas may be found.

FERROUS OXALATE.—The use of this developer has been completely abandoned, mainly because plates are actually slower when developed with it than with the organic developers, and also because of the deposition of calcium oxalate and basic iron salts in the gelatine film. On the other hand, it has the great advantage of giving an image composed of nothing but pure silver which is a neutral colour, that is, without selective absorption, and is, therefore, valuable in certain photochemical investigations. Ferrous oxalate is a yellow stable powder, insoluble in water, which can be pre-

pared by mixing ferrous sulphate with oxalic acid or a soluble oxalate, as follows:

Ferrous sulphate	278 parts
Water	500 parts

Dissolve and add:

Potassium oxalate, neutral	184 parts
Water	500 parts

Mix the two solutions, filter and wash the precipitate with four or five lots of distilled water, and dry. The result should be 180 parts of ferrous oxalate. Oxalic acid 126 parts may be used instead of the potassium salt. Ferrous oxalate is soluble in excess of neutral potassium oxalate, or other alkaline oxalate. It is obvious that the developer may be prepared in two ways: either by dissolving the dry salt in oxalate solution, or by adding ferrous sulphate solution to excess of an alkaline oxalate, when it will remain in solution. Potassium oxalate is used in preference to the corresponding ammonium and sodium oxalates, because it is more soluble. Consequently, it will dissolve more of the ferrous oxalate, which is the active agent in development. The strongest developer can be made as follows:

Potassium oxalate	500 g	8 oz.
Water	1000 ccm	16 oz.

Boil and add:

Ferrous oxalate, dry	100 g	1 3/5 oz.
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Allow to cool slightly and immediately bottle. This practically forms a saturated solution of ferrous oxalate. This method is not so convenient as using separate solutions, for which the following stock solutions are required:

A. Ferrous sulphate	330 g	5 1/4 oz.
Water	1000 ccm	16 oz.
Sulphuric acid	1 ccm	7 min.

The iron salt should preferably be pure, and, if covered at all with whitish or yellowish powder, a little excess should be allowed in weighing out. The crystals are to be placed in a flask, covered with water, well stirred, and the water poured off. Then the acid should be added to about three-fourths of the water, the salt dissolved, and the bulk made up with the remainder of the water. As this solution readily oxidises on exposure to the air, it is better to keep it in small bottles, and fill them right up to the cork:

B. Potassium oxalate	330 g	5¼ oz.
Hot water	1000 ccm	16 oz.

For use add 1 part of A to 4 parts of B. The usual strength is 1:3, but this is apt to deposit the insoluble ferrous oxalate. If the order of mixing is reversed, the insoluble iron salt is at once precipitated, as there is no excess of oxalate to dissolve it. With this developer the image appears in from 10 to 30 seconds and is complete in 2 to 5 minutes. Potassium bromide, may, of course, be added as restrainer. As an accelerator a few drops of weak hypo solution may be used, about 10 drops of a 1:200 solution to 100 ccm or 4 drops to the ounce; but this is apt to give fog.

Modifications have been suggested mainly for use with gelatino-chloride lantern plates, and, by suitably prolonging the exposure and modifying the developer, any tone can be obtained from black to red. For black or purple tones the following may be used:

A. Potassium citrate, neutral	450 g	7 1/5 oz.
Potassium oxalate, neutral	112 g	784 gr.
Water	1000 ccm	16 oz.
B. Ferrous sulphate	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.

Mix in equal parts.

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I. Potassium oxalate	125 g	2 oz.
Potassium citrate	42 g	$\frac{1}{2}$ oz.
Water	1000 ccm	16 oz.

This gives cold tones.

II. Citric acid	333 g	5 $\frac{1}{3}$ oz.
Ammonium carbonate	250 g	4 oz.
Water	1000 ccm	16 oz.

Gives warm tones.

III. Citric acid	500 g	8 oz.
Ammonium carbonate	166 g	2 $\frac{2}{3}$ oz.
Water	1000 ccm	16 oz.

Gives extra warm tones.

IV. Ferrous sulphate	333 g	5 $\frac{1}{3}$ oz.
Sulphuric acid	12.5 ccm	96 min.
Water	1000 ccm	16 oz.

For use add 1 part of IV to 3 parts of I, II, or III. Another modification is:

Citric acid	250 g	4 oz.
Magnesium carbonate	157 g	2 $\frac{1}{2}$ oz.
Water	1000 ccm	16 oz.

This can be used instead of I, II, or III given above.

Should any calcium oxalate be precipitated in the gelatine, a weak hydrochloric acid bath, about 1 per cent, will remove the precipitate.

GLYCIN.—This is a slow-working very clean developer giving images of a neutral grey colour, and is very suitable for stand development.

Glycin paste (Hübl).—

Sodium sulphite, dry	125 g	1 $\frac{1}{4}$ oz.
Warm water	400 ccm	4 oz.
Glycin	100 g	1 oz.

Mix well and add gradually:

Potassium carbonate	500 g	5 oz.
Water to make	750 ccm	7½ oz.

Carbonic acid is given off and a thin cream formed, which must be well shaken and mixed with 12 times its volume of water before use.

Glycin-soda.—

Glycin	15 g	115 gr.
Sodium sulphite, dry	37.5 g	288 gr.
Sodium carbonate, dry	55 g	422 gr.
Water	1000 ccm	16 oz.

Glycin-potash (Hübl).—

Potassium metabisulphite	175 g	2 oz., 384 gr.
Caustic potash	175 g	2 oz., 384 gr.
Glycin	120 g	922 gr.
Water	1000 ccm	16 oz.

Mix 1 part with 25 parts water.

HYDROCHINON.—One solution:

Sodium sulphite, dry	37.5 g	288 gr.
Hydrochinon	10 g	77 gr.
Sodium carbonate, cryst.	150 g	1152 gr.
Hot water	1000 ccm	16 oz.

Two solution:

A. Hydrochinon	25 g	192 gr.
Sodium sulphite, dry	50 g	384 gr.
Water	1000 ccm	16 oz.

B. Potassium carbonate 10 per cent solution

Mix 2 parts A with 1 part B.

One solution:

Hydrochinon	15 g	115 gr.
Sodium sulphite, dry	150 g	1152 gr.
Formaldehyde	20 ccm	154 min.
Water	1000 ccm	16 oz.

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Especially suitable for black and white line work. The following also is excellent for the same purpose:

A. Hydrochinon	8.5 g	65 gr.
Potassium metabisulphite	8.5 g	65 gr.
Potassium bromide	2.0 g	16 gr.
Water	1000 ccm	16 oz.
B. Caustic potash	17 g	131 gr.
Water	1000 ccm	16 oz.

Mix in equal parts.

For very fine grained images, add 50 to 300 g (384 gr. to 5½ oz.) of ammonium chloride to every liter (16 oz.) of normal hydrochinon developer.

Rapid acting, soft-working developer (Lainer):

A. Hydrochinon	10 g	77 gr.
Sodium sulphite, dry	20 g	154 gr.
Potassium ferrocyanide	120 g	922 gr.
Water	1000 ccm	16 oz.
B. Caustic potash	50 g	384 gr.
Water	1000 ccm	16 oz.

For use mix 10 parts A with 1 part B. Development will be completed in about one minute. If caustic soda is used, the ferrocyanide may be reduced to one-fifth. For general use it is better to mix the developer with an equal volume of water.

One solution developer (Lainer):

Sodium sulphite, dry	75 g	576 gr.
Hydrochinon	50 g	384 gr.
Potassium ferrocyanide	175 g	1344 gr.
Caustic potash	165 g	1267 gr.
Water	1000 ccm	16 oz.

For use dilute with 4 parts of water.

For Eastman Motion Picture Film, Negative and Positive.—

Hydrochinon	390 g	13 oz.
Sodium sulphite, dry	2000 g	4 lb.
Sodium carbonate, dry	2000 g	4 lb.
Potassium bromide	90 g	3 oz.
Water	40 litres	1280 oz.

Temperature 65° to 68° F. For film developed on drum add to above 45 g (1½ oz.) potassium bromide and develop at 62° F.

Cramer's Contrast Developer for Line Work.—

A. Hydrochinon	45 g	1½ oz.
Sodium sulphite, dry	30 g	1 oz.
Sulphuric acid	4 ccm	60 min.
Water	1000 ccm	32 oz.
B. Sodium carbonate, dry	30 g	1 oz.
Potassium carbonate	90 g	3 oz.
Potassium bromide	8 g	120 gr.
Sodium sulphite, dry	90 g	3 oz.
Water	1000 ccm	32 oz.

For use mix in equal volumes. Develop for 6 to 10 minutes. Temperature 21° C. (70° F.). This may also be used for X-ray and lantern plates.

KODELON.—Paramidophenol hydrochloride is sold by the Eastman Kodak Co. under this name, especially for use with developing papers, under which heading formulas may be found.

METOL.—A very rapid developer, rarely used alone, but generally in combination with hydrochinon or pyrogallol. Also marketed by the Eastman Kodak Co. under the name Elon. Motol is another synonym.

Metol-potash.—

A. Metol	10 g	77 gr.
Sodium sulphite, dry	50 g	384 gr.
Water	1000 ccm	16 oz.

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B. Potassium carbonate	100 g	1 oz.
Water	1000 ccm	10 oz.

Mix 3 parts A with 1 part B.

Metol-soda.—Replace the potassium carbonate in B by

Sodium carbonate, dry	50 g	384 gr.
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For use mix A and B in equal volumes.

One solution:

Metol	15 g	115 gr. 70
Sodium sulphite, dry	60 g	460 gr. 115
Sodium carbonate, dry	75 g	576 gr.
Potassium bromide	1.5 g	11.5 gr.
Water	1000 ccm	16 oz.

For studio work mix with an equal volume of water. For landscape work mix 1 part with 2 parts water.

Metol poisoning (Beers).—The hands should be dipped into a saturated solution of paraffine in gasoline (petrol) before using metol. Less severe forms of the trouble can be treated with:

Carbolic acid	21 g	160 gr.
Powdered calamine	31.5 g	240 gr.
Zinc oxide	63 g	480 gr.
Glycerine	65 ccm	1 oz.
Lime water	250 ccm	4 oz.
Rose water to	1000 ccm	16 oz.

Rub the zinc and calamine into a smooth paste with the glycerine, and add the carbolic acid and the rest of the waters. This may be applied during the day. The following should be applied at night:

Salicylic acid	1 g	15 gr.
Boric acid	4 g	60 gr.
Starch powder	8 g	120 gr.
Zinc oxide	4 g	60 gr.
Petrolatum	32 g	1 oz.

Flexible collodion should be applied to all cracks during the day.

Metol-hydrochinon (Cramer).—

A. Metol	2 g	30 gr.
Hydrochinon	6 g	90 gr.
Sodium sulphite, dry	30 g	1 oz.
Water	750 ccm	25 oz.
B. Sodium carbonate, dry	15 g	½ oz.
Water	750 ccm	25 oz.

For use mix in equal volumes.

Ansco Metol-Hydrochinon.—

Metol	1.56 g	48 gr.
Hydrochinon	0.78 g	24 gr.
Sodium sulphite, dry	9 g	280 gr.
Sodium carbonate, dry	6 g	180 gr.
Potassium bromide	0.39 g	12 gr.
Water	1000 ccm	64 oz.

Time, 5 or 6 minutes at 18° C. (65° F.).

M. Q. Eastman Motion Picture Film, Negative & Positive.—

Elon (metol)	12 g	180 gr.
Sodium sulphite, dry	1590 g	3 lb., 5 oz.
Hydrochinon	240 g	8 oz.
Potassium bromide	36 g	1 oz., 63 gr.
Sodium carbonate, dry	750 g	1 lb., 9 oz.
Citric acid	28 g	400 gr.
Potassium metabisulphite	60 g	2 oz.
Water	40 liters	1280 oz.

Temperature 65° F. (18° C.).

Eastman Portrait & Commercial Films.—Metol-hydrochinon tank formula.—

Elon (metol)	0.8 g	170 gr.
Sodium sulphite, dry	23.5 g	12 oz.

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Sodium bisulphite	0.5 g	$\frac{1}{4}$ oz.
Hydrochinon	1.5 g	$\frac{3}{4}$ oz.
Sodium carbonate, dry	3 g	$1\frac{1}{2}$ oz.
Potassium bromide	0.4 g	95 gr.
Water to	1000 ccm	512 oz.

Temperature 18° C. (65° F.). Development from 10 to 14 minutes. The following strengthening solution may be used to keep the volume and strength up to standard:

Elon (metol)	0.75 g	85 gr.
Sodium sulphite, dry	23.5 g	6 oz.
Sodium bisulphite	0.5 g	55 gr.
Hydrochinon	1.5 g	170 gr.
Potassium bromide	0.4 g	45 gr.
Water to	1000 ccm	256 oz.

To give this stock solution greater keeping quality, the sodium carbonate is not added until the strengthening solution is used. For use dissolve 1 part of sodium carbonate, dry, in 32 parts of the above solution.

Standard Postcard Plates.—

Elon (metol)	3.9 g	$\frac{1}{2}$ oz.
Sodium sulphite, dry	31.25 g	4 oz.
Hydrochinon	7.8 g	1 oz.
Sodium carbonate, dry	47 g	6 oz.
Potassium bromide	195 g	$\frac{1}{4}$ oz.
Water	1000 ccm	128 oz.

For use mix with an equal volume of water.

Stanley Plates.—For these plates the following metol-hydrochinon developer is recommended:

Elon (metol)	3.9 g	30 gr.
Sodium sulphite, dry	31.25 g	$\frac{1}{2}$ oz.
Hydrochinon	3.9 g	30 gr.
Sodium carbonate, dry	15.625 g	$\frac{1}{4}$ oz.
Water	1000 ccm	16 oz.

For use mix 1 part with 7 parts water, and use at 65° F.

Seed Graflex Plates—Contrast Developer.—

A. Elon (metol)	3.9 g	60 gr.
Sodium sulphite, dry	47 g	1½ oz.
Hydrochinon	7.8 g	120 gr.
Potassium bromide	6.5 g	50 gr.
Water	1000 ccm	32 oz.
B. Sodium carbonate, dry	312.5 g	5 oz.
Water	1000 ccm	16 oz.

For use mix 3 parts A, 1 part B, 2 parts water.

Metol-Hydrochinon-Pyro.—

A. Elon (metol)	2.27 g	35 gr.
Sodium sulphite, dry	31.25 g	1 oz.
Hydrochinon	8.5 g	130 gr.
Sodium carbonate, dry	52 g	800 gr.
Water	1000 ccm	32 oz.
B. Sodium bisulphite (or potassium metabisulphite)	9.2 g	70 gr.
Potassium bromide	2.6 g	20 gr.
Pyrogallol	62.5 g	1 oz.
Water	1000 ccm	16 oz.

For use mix 8 parts A and 1 part B.

Seed Plates.—

A. Elon (metol)	4 g	120 gr.
Sodium sulphite, dry	31.25 g	2 oz.
Hydrochinon	4 g	120 gr.
Potassium bromide	2 g	60 gr.
Water	1000 ccm	64 oz.
B. Sodium carbonate, dry	94 g	1½ oz.
Water	1000 ccm	16 oz.

For tray developer, use A 4 parts, B 1 part, water 4 parts.

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Eastman X-Ray Film.—

Elon (metol)	2.7 g	40 gr.
Sodium sulphite, dry	120 g	4 oz.
Hydrochinon	11 g	160 gr.
Sodium carbonate, dry	60 g	2 oz.
Potassium bromide	2.1 g	32 gr.
Water	1200 ccm	40 oz.

The above is for tray development ; for tank, use :

Elon (metol)	42 g	1 oz., 240 gr.
Sodium sulphite, dry	2040 g	68 oz.
Hydrochinon	185 g	6 oz., 96 gr.
Sodium carbonate, dry	1020 g	34 oz.
Potassium bromide	36 g	550 gr.
Water to	22000 ccm	6 gal.

Hammer Postal Plate.—Stock solutions :

1. Metol	2.7 g	165 gr.
Hydrochinon	10 g	1½ oz.
Sodium sulphite	38 g	6 oz.
Water	1000 ccm	128 oz.
2. Sodium carbonate	78 g	10 oz.
Water	1000 ccm	128 oz.

For use mix equal parts of Nos. 1 and 2.

One solution developer :

Metol	0.15 g	22½ gr.
Hydrochinon	0.30 g	45 gr.
Sodium sulphite	12 g	¾ oz.
Sodium carbonate	4 g	¼ oz.
Potassium bromide	0.4 g	6 gr.
Water	1000 ccm	32 oz.

For use mix with an equal volume of water.

Rexo Film.—Dissolve the chemicals in the following order :

Metol	1.25 g	20 gr.
Sodium sulphite, dry	14 g	½ oz.

Hydrochinon	4 g	60 gr.
Sodium carbonate, dry	21 g	$\frac{3}{4}$ oz.
Potassium bromide	1 g	15 gr.
Water	1150 ccm	40 oz.

NEOL.—This is a fine, white, crystalline powder, insoluble in water except in the presence of caustic alkali, which should be very pure, so that the manufacturers recommend only the use of Hauff alkali, which may be obtained either in solid form or in solution, in connection with this developer. The alkaline solution is prepared as follows:

Hauff alkali (caustic soda)	400 ccm	2 oz.
Water	1000 ccm	5 oz.

The developing solution is compounded as follows. For tray development; time, three to five minutes:

Water	1000 ccm	16 oz.
Sodium sulphite, anhydrous	5 g	40 gr.
Neol lye solution, as above	20 ccm	$\frac{1}{3}$ oz.
Neol	4 g	31 gr.

In case of over-exposure 10 to 20 drops of 10 per cent potassium bromide solution may be added.

For tank development, 15 to 20 minutes:

Water	100 liters	25 gal.
Sodium sulphite, anhydrous	300 g	10 oz.
Neol lye solution	1200 g	40 oz.
Neol	200 g	$6\frac{3}{4}$ oz.
Potassium bromide, 10% sol.	15 ccm	$\frac{1}{2}$ oz.

Neol is claimed to work free from fog and therefore to be excellent for underexposed negatives.

ORTOL.—A molecular compound of two molecules of metol with one of hydrochinon:

A. Potassium metabisulphite	7.5 g	53.7 gr.
Ortol	15 g	115 gr.
Water	1000 ccm	16 oz.

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B. Sodium carbonate, dry	60 g	460 gr.
Sodium sulphite, dry	90 g	690 gr.
Potassium bromide	1.5 g	11.5 gr.
Hypo	0.5 g	3.8 gr.
Water	1000 ccm	16 oz.

The same weight of potassium carbonate may be used instead of the soda. Mix 1 part A, 1 part B, and 1 part water; for a more rapid developer mix A and B in equal volumes.

Stock solutions for Hammer plates:

1. Ortol	21 g	160 gr.
Water	1000 ccm	16 oz.
2. Sodium carbonate	31 g	240 gr.
Sodium sulphite	15.5 g	120 gr.
Water	1000 ccm	16 oz.

For use take:

No. 1 solution	125 ccm	1 oz.
No. 2 solution	125 ccm	1 oz.
Water	750 ccm	6 oz.

PARAMIDOPHENOL.—One solution:

Paramidophenol hydrochloride	4 g	31 gr.
Sodium sulphite, dry	40 g	310 gr.
Sodium carbonate, dry	40 g	310 gr.
Water	1000 ccm	16 oz.

Ready for use. Does not keep so well as in separate solutions.

A. Paramidophenol hydrochloride	20 g	154 gr.
Water	1000 ccm	16 oz.
B. Sodium sulphite, dry	60 g	460 gr.
Potassium carbonate	120 g	920 gr.
Water	2000 ccm	32 oz.

Mix 1 part A with 2 parts B. More suitable for papers and transparencies than negatives.

One solution, similar to rodinal (Ermen):

Water	625 ccm	11 oz.
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Boil, allow to cool for 5 minutes, and add a few crystals of potassium metabisulphite; then add:

Paramidophenol hydrochloride	50 g	385 gr.
Potassium metabisulphite	150 g	2 oz., 192 gr.

Stir until dissolved. Then make a solution of:

Caustic soda	215 g	3½ oz.
Water	500 ccm	8¾ oz.

and add with constant stirring about 340 to 350 ccm (6 oz.) to the paramidophenol solution. At first a precipitate of the paramidophenol base is formed, but, as more caustic soda is added, this dissolves. Enough soda solution should be added to nearly dissolve the precipitate; then add:

Water to make	1000 ccm	16 oz.
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Bottle and allow to cool. Should any paramidophenol crystallise out, more soda must be added to nearly dissolve it. It is very important to leave some undissolved. For use mix 1 part with 10 parts water with some bromide for plates, and with 40 parts water for papers.

Liquid developers consisting of paramidophenol and an alkali are marketed under such names as rodinal, azol, activol, citol, paranol, paramol, certinal, kalogen, etc.

PARAPHENYLENDIAMINE, for fine-grained images (Lumière & Seyewetz).—The following gives a finer grain image than most developers:

Paraphenylenediamine	10 g	77 gr.
Sodium sulphite, dry	60 g	460 gr.
Water	1000 ccm	16 oz.

PYROCATECHIN OR KACHIN.—Also called Elconal.

A. Pyrocatechin	1 g	8 gr.
Water	1000 ccm	16 oz.
B. Potassium carbonate	200 g	1 oz.
Water	1000 ccm	5 oz.

For use mix 10 parts A with 1 part B. Gives brownish

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images, suitable for transparencies. The developer can only be used once, as it spoils rapidly.

Pyrocatechin-Potash.—

A. Pyrocatechin	200 g	3 oz., 224 gr.
Sodium sulphite, dry	400 g	7 oz.
Water	1000 ccm	16 oz.
B. Potassium carbonate	120 g	922 gr.
Water	1000 ccm	16 oz.

For use mix in equal parts.

One solution:

Potassium metabisulphite	100 g	2 oz.
Potassium carbonate	150 g	3 oz.
Water	400 ccm	8 oz.

Mix in a mortar and add:

Pyrocatechin	350 g	7 oz.
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This forms a thick cream which must be stored in well-corked bottles. Mix 1 part with 20 parts of water.

Rapid one-solution developer (Ellon).—

Sodium sulphite, dry	250 g	4 oz.
Caustic soda	35 g	269 gr.
Pyrocatechin	50 g	384 gr.
Water	1000 ccm	16 oz.

Mix 1 part with 15 parts of water.

Two-solution (Vogel).—

A. Sodium sulphite, dry	50 g	384 gr.
Pyrocatechin	20 g	154 gr.
Water	1000 ccm	16 oz.
B. Caustic soda	14 g	108 gr.
Water	1000 ccm	16 oz.

Mix 1 part A, 1 part B with 4 parts water.

Pyrocatechin-acetone (Hanneke).—

Pyrocatechin	10 g	77 gr.
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Sodium sulphite, dry	12 g	92 gr.
Water	1000 ccm	16 oz.

Mix just before use 12 parts with 1 part acetone.

PYROGALLOL.—Pyro-ammonia was once the favorite developer, but is rarely used now on account of its variability, due to the evaporation of the ammonia:

A. Sodium sulphite, dry	50 g	384 gr.
Sulphuric acid	6 drops	3 drops
Pyrogallol	14 g	107.5 gr.
Water	500 ccm	8 oz.
B. Potassium bromide	10 per cent solution	
C. Ammonia, sp. gr. 0.91	200 ccm	4 oz.
Water	1000 ccm	20 oz.

For use mix 5 parts A, 1 part B, 5 parts C, and 50 parts water.

Pyro-glycerine (Edwards).—

A. Pyrogallol	40 g	1 oz.
Glycerine	40 ccm	1 oz.
Denatured alcohol (methylated spirit)	250 ccm	6¼ oz.
B. Potassium bromide	15 g	65 gr.
Ammonia	40 ccm	1 oz.
Glycerine	40 ccm	1 oz.
Water	250 ccm	6¼ oz.

For use mix 1 part A, 1 part B, and 30 parts water.

For great contrasts, suitable for black and white line work or photomechanical or process plates (Mawson):

A. Pyrogallol	7 g	54 gr.
Ammonium bromide	7 g	54 gr.
Potassium metabisulphite	7 g	54 gr.
Water	1000 ccm	16 oz.
B. Ammonia, sp. gr. 0.91	21 ccm	160 min.
Water	1000 ccm	16 oz.

For use, mix in equal volumes.

Pyro-Soda.—

A. Sodium sulphite, dry	50 g	1 oz.
Sulphuric acid	6 ccm	3 drops
Pyrogallol	14 g	122 gr.
Water	500 ccm	10 oz.
B. Sodium carbonate, cryst.	50 g	1 oz.
Water	500 ccm	10 oz.

For use mix in equal volumes.

The "B. J." Pyro-Soda.—Specially recommended by the *British Journal of Photography*. It keeps well and does not stain:

A. Pyrogallol	16.6 g	1 oz.
Sodium sulphite, dry	66 g	4 oz.
Potassium metabisulphite	16.6 g	1 oz.
Hot water	1000 ccm	60 oz.

Mix the sulphite and metabisulphite dry, and add to half the water; boil for one minute, add the pyro, then the remainder of the water, and cool.

B. Sodium carbonate, cryst.	200 g	12 oz.
Water	1000 ccm	60 oz.

For use mix 1 part A, 1 part B and 2 parts water.

Hurter & Driffield Standard Developer.—Recommended for plate testing:

Pyrogallol	8 parts
Sodium carbonate, cryst.	40 parts
Sodium sulphite, cryst.	40 parts
Water	1000 parts

Pyro-Caustic (Valenta).—A very rapid stainless developer, acting very much like metol:

A. Sodium sulphite, dry	80 g	615 gr.
Pyrogallol	25 g	192 gr.
Water	1000 ccm	16 oz.

B. Caustic potash	11.5 g	88.3 gr.
(or Caustic soda)	8.5 g	65.3 gr.
Water	1000 ccm	16 oz.

For use mix 1 part A, 1 part B and 1 part water.

Pyro-Acetone (Lumière).—

A. Pyrogallol	100 g	768 gr.
Sodium sulphite, dry	200 g	1536 gr.
Water	1000 ccm	16 oz.

Potassium metabisulphite must not be used, nor must acid be added. For use mix A 8 parts, acetone 8 parts and water 100 parts.

Pyro-Potash (Beach).—

A. Pyrogallol	100 g	1 oz.
Sodium sulphite, dry	200 g	2 oz.
Sulphurous acid	400 ccm	4 oz.
Hot water	500 ccm	5 oz.

Dissolve the sulphite; when cold add the acid, and then the pyro.

B. Potassium carbonate	333 g	3 oz.
Sodium sulphite, dry	111 g	1 oz.
Hot water	1000 ccm	10 oz.

For use mix 1 part A, 2 parts B and 16 parts water.

Cramer's Pyro Tank Developer.—

Sodium bisulphite	19.5 g	2½ oz.
Sodium sulphite, dry	19.5 g	2½ oz.
Hot water	500 ccm	64 oz.

Dissolve and boil for 5 minutes; then add:

Pyrogallol	15.5 g	2 oz.
Sodium carbonate, dry	27.5 g	3½ oz.
Cold water	500 ccm	64 oz.

To keep up to original strength and bulk, add equal volumes of the following (A and B) after each day's working:

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A. Sodium bisulphite	39 g	2½ oz.
Sodium sulphite, dry	39 g	2½ oz.
Hot water	1000 ccm	64 oz.

Boil for 5 minutes and add when cool:

Pyrogallol	31 g	2 oz.
B. Sodium carbonate, dry	62.5 g	4 oz.
Water	1000 ccm	64 oz.

Potassium metabisulphite must not be substituted for the bisulphite in the above formulas.

Pyro-soda developer for Cramer plates.—

A. Sodium bisulphite	5 g	75 gr.
Pyrogallol	30 g	1 oz.
Water	480 ccm	16 oz.
B. Sodium sulphite, dry	60 g	2 oz.
Water	480 ccm	16 oz.
C. Sodium carbonate, dry	30 g	1 oz.
Water	480 ccm	16 oz.

For tray use:

Solution A	100 ccm	1 oz.
Solution B	100 ccm	1 oz.
Solution C	100 ccm	1 oz.
Water	800 ccm	8 oz.

For tank use:

Solution A	250 ccm	2½ oz.
Solution B	350 ccm	3½ oz.
Solution C	250 ccm	2½ oz.
Water	5800 ccm	58 oz.

Temperature 65° F. Time 20 minutes.

*Cramer's Pyro-Acetone.—*Stock pyro solution:

Sodium bisulphite	3.25 g	25 gr.
Pyrogallol	62.5 g	1 oz.
Sodium sulphite, dry	182 g	2¾ oz.
Water	1000 ccm	16 oz.

For tray, use: Stock pyro solution 72 ccm, acetone 24 ccm, water 928 ccm; or pyro solution 1 oz., acetone 3 drams, water 14 oz.

For tank, use: Pyro solution 21.5 ccm, acetone 12.5 ccm, water 1000 ccm; or pyro solution $1\frac{1}{4}$ oz., acetone 5 drams, water 58 oz.

Temperature 21° C. (70° F.) Time 30 minutes.

AnSCO Pyro-Soda.—

1. Potassium metabisulphite	16.3 g	250 gr.
Sodium sulphite, dry	62.5 g	2 oz.
Pyrogallol	16.3 g	250 gr.
Water	1000 ccm	32 oz.
2. Sodium carbonate, dry	70 g	$2\frac{1}{4}$ oz.
Water	1000 ccm	32 oz.

For use mix No. 1, 1 part, No. 2, 1 part, water, 2 parts.

Time of development 5 minutes at 18° C. (65° F.).

Kodak Film Pack Pyro formula.—

Pyrogallol	1.7 g	22 gr.
Sodium sulphite, dry	5 g	60 gr.
Sodium carbonate, dry	6.5 g	75 gr.
Water	1000 ccm	27 oz.

Temperature 18° C. (65° F.). Develop for 20 minutes.

For Eastman N-C & Autographic Film.—

A. Pyrogallol	35.7 g	1 oz.
Sulphuric acid, c. p.	3 ccm	20 min.
Water	1000 ccm	28 oz.
B. Sodium sulphite, dry	107 g	3 oz.
Sodium carbonate, dry	71.5 g	2 oz.
Water	1000 ccm	28 oz.

For use mix 1 part A, 1 part B, 8 parts water.

For Seed and Stanley Plates.—For tray developer:

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A. Sodium or potassium bisulphite	11.7 g	90 gr.
Pyrogallol	62.5 g	1 oz.
Water	1000 ccm	16 oz.
B. Sodium sulphite, dry	94 g	1½ oz.
Water	1000 ccm	16 oz.
C. Sodium carbonate, dry	78 g	1¼ oz.
Water	1000 ccm	16 oz.

For use mix 1 part A, 1 part B, 1 part C, and 7 parts water.

For tank developer :

A. Sodium or potassium bisulphite	9 g	70 gr.
Potassium bromide	0.9 g	7 gr.
Pyrogallol	62.5 g	1 oz.
Water	1000 ccm	16 oz.
B. Sodium sulphite, dry	109 g	1¾ oz.
Water	1000 ccm	16 oz.
C. Sodium carbonate, dry	78 g	1¼ oz.
Water	1000 ccm	16 oz.

For use mix

A solution	36 ccm	4½ oz.
B solution	36 ccm	4½ oz.
C solution	36 ccm	4½ oz.
Water to	1000 ccm	128 oz.

Temperature 65° F. Develop 15 minutes.

For Seed 30 and Graflex plates use :

A solution	47 ccm	6 oz.
B solution	47 ccm	6 oz.
C solution	47 ccm	6 oz.
Water to	1000 ccm	128 oz.

Temperature 65° F. Develop 15 minutes.

Pyro-Acetone for Hammer Plates.—Stock solutions :

1. Sodium sulphite	129 g	3 oz.
Water	1000 ccm	23¼ oz.

Hydrometer test, 75°.

2. Pyrogallol	62.5 g	1 oz.
Oxalic acid	2 g	15 gr.
Water	1000 ccm	16 oz.

For use, take:

No. 1 solution	118 ccm	1 oz.
No. 2 solution	59 ccm	$\frac{1}{2}$ oz.
Acetone	29.5 ccm	$\frac{1}{4}$ oz.
Water	588 ccm	5 oz.

Pyro for Hammer Plates.—Stock solutions:

1. Sodium sulphite	156 g	2 $\frac{1}{2}$ oz.
Water	1000 ccm	16 oz.

Hydrometer test, 80°.

2. Sodium carbonate	78 g	1 $\frac{1}{4}$ oz.
Water	1000 ccm	16 oz.

Hydrometer test, 40°.

3. Potassium metabisulphite	7.8 g	60 gr.
Pyrogallol	62.5 g	1 oz.
Water	1000 ccm	16 oz.

For tray take:

No. 1 solution	30 ccm	$\frac{1}{2}$ oz.
No. 2 solution	30 ccm	$\frac{1}{2}$ oz.
No. 3 solution	30 ccm	$\frac{1}{2}$ oz.
Water (winter)	360 ccm	6 oz.
Water (summer)	480 ccm	8 oz.

For tank take:

No. 1 solution	43 ccm	5 $\frac{1}{2}$ oz.
No. 2 solution	43 ccm	5 $\frac{1}{2}$ oz.
No. 3 solution	43 ccm	5 $\frac{1}{2}$ oz.
Water	870 ccm	11 $\frac{1}{2}$ oz.

Bromide potassium, saturated solution, 0.2 ccm, 12 drops.

Develop 12 minutes at 65° F.

Rexo Film.—Make the following solution:

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Pyrogallol	28 g	1 oz.
Oxalic acid	0.5 g	8 gr.
Water	225 ccm	8 oz.

For use make the following solutions, Nos. 1 and 2 and mix equal parts:

1. Pyro solution as above	56 ccm	2 oz.
Water	500 ccm	18 oz.
2. Sodium sulphite, dry	28 g	1 oz.
Sodium carbonate, dry	14 g	½ oz.
Water	560 ccm	20 oz.

Tank developer:

No. 1 solution	56 ccm	2 oz.
No. 2 solution	56 ccm	2 oz.

For 15 minute development add 225 ccm (8 oz.) of water at 65° F.

For 30 minute development add 560 ccm (20 oz.) of water at 65° F.

For Wratten Panchromatic Plates.—

A. Sodium or potassium bisulphite	6 g	90 gr.
Pyrogallol	30 g	1 oz.
Water	500 ccm	16 oz.
B. Sodium sulphite, dry	45 g	1½ oz.
Water	500 ccm	16 oz.
C. Sodium carbonate, dry	37.5 g	1¼ oz.
Water	500 ccm	16 oz.

For tray development, mix 1 part A, 1 part B, 1 part C, and 7 parts water.

For tank development, mix 1 part A, 1 part B, 1 part C, and 25 parts water, to which add for every 500 parts, 2 parts of 1 per cent solution of potassium bromide.

The times for development for the above tray and tank developers are:

Temperature	Tray	Tank
50° F.	12 min.	36 min.
65° F.	6 min.	18 min.
80° F.	3 min.	9 min.

For Standard Plates.—The stock solutions are as above. To develop Standard Extra, Imperial Portrait, Thermic, or Polychrome plates, use 1 part A, 1 part B, 1 part C, 7 parts water. For Orthonon plates use the same proportions of A, B, C, but 12 parts water.

For tank developer for Standard Plates, use the same formula as for Seed plates, except for the Standard Polychrome, for which the formula is:

A solution	54.6 ccm	3 oz.
B solution	54.6 ccm	3 oz.
C solution	54.6 ccm	3 oz.
Water	1000 ccm	55 oz.

Temperature 65° F. Develop 15 minutes.

For Eastman Portrait, Commercial, Commercial Ortho & Commercial Panchromatic Films.—The formulas for the tray developer are the same as for the Wratten Panchromatic plates. For the tank developer the same formulas are used, in the following proportions:

A solution	43 ccm	5½ oz.
B solution	43 ccm	5½ oz.
C solution	43 ccm	5½ oz.
Water to	1000 ccm	128 oz.

Pyro-Metol.—

A. Pyrogallol	8.3 g	64 gr.
Metol	7 g	54 gr.
Potassium metabisulphite	18.75 g	144 gr.
Potassium bromide	3.12 g	24 gr.
Water	1000 ccm	16 oz.

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B. Sodium carbonate, cryst.	156 g	2½ oz.
Water	1000 ccm	16 oz.

Mix in equal volumes.

For Hammer Plates.—Stock solutions :

1. Sodium sulphite	156 g	2½ oz.
Water	1000 ccm	16 oz.
2. Sodium carbonate	78 g	1¼ oz.
Water	1000 ccm	16 oz.
3. Potassium metabisulphite	7.8 g	60 gr.
Metol	15.6 g	¼ oz.
Pyrogallol	46.8 g	¾ oz.
Potassium bromide	3.9 g	30 gr.
Water	1000 ccm	16 oz.

For tank take :

No. 1 solution	41 ccm	5¼ oz.
No. 2 solution	41 ccm	5¼ oz.
No. 3 solution	41 ccm	5¼ oz.
Water	877 ccm	112¼ oz

Develop 10 minutes at 65° F.

For tray development :

4. Pyrogallol	37 g	1 oz.
Metol	4.6 g	60 gr.
Water	1000 ccm	27 oz.
Solution No. 2 as above		
Solution No. 3 as above		

For use take :

No. 4 solution	100 ccm	1 oz.
No. 2 solution	100 ccm	1 oz.
No. 3 solution	100 ccm	1 oz.
Water	800 to 1200 ccm	8 to 12 oz.

Pyro-Metol Tank & Tray Developer for Easiman Portrait & Commercial Films.—

A. Sodium bisulphite	15.5 g	¼ oz.
Elon (metol)	15.5 g	¼ oz.
Pyrogallol	62.5 g	1 oz.
Potassium bromide	4 g	60 gr.
Water	1000 ccm	32 oz.
B. Sodium sulphite, dry	156 g	5 oz.
Water	1000 ccm	32 oz.
C. Sodium carbonate, dry	78 g	2½ oz.
Water	1000 ccm	32 oz.

For tank development mix 2 parts each of A, B, and C with 32 parts water. Temperature 18° C. (65° F.). Development from 9 to 12 minutes. This may be used repeatedly if kept up to normal strength. For strengthening add 2 parts each of A, B, and C to 8 parts water. For tray development mix 2 parts each of A, B, and C with 16 parts water.

Cramer's Pyro-Metol Developer.—

A. Metol	30 g	1 oz.
Sodium bisulphite	1 g	75 gr.
Pyrogallol	10 g	½ oz.
Water	600 ccm	30 oz.
B. Sodium sulphite, dry	120 g	4 oz.
Water	600 ccm	30 oz.
C. Sodium carbonate, dry	120 g	4 oz.
Water	600 ccm	30 oz.

For use mix:

Solution A	10 ccm	½ oz.
Solution B	10 ccm	½ oz.
Solution C	10 ccm	½ oz.
Water	200 to 300 ccm	10 to 15 oz.

B and C may be mixed together and keep well in one solution, which should be diluted for use with from 6 to 10 parts of water.

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TOZOL.—An Eastman developer. Formula will be found under developing papers.

Fixing and Clearing

FIXING.—The rapidity with which plates, films, and papers fix is dependent on the strength of the bath, its temperature, and the degree of exhaustion or previous use. A 40 to 45 per cent solution of hypo is the strongest bath that should be used and is the most rapid in action. Plain, alkaline, acid, or acid and alum baths may be used. The first two are generally used for printing-out papers, and the latter for plates, film, and developed papers. In all cases, the temperature should be maintained about normal, 18° C. (65° F.). A bath should not be used too long, as the more it is used, the greater its saturation in silver salts, therefore, the longer it will take to fix properly and the greater the chance for the formation of insoluble, transparent silver salts which are difficult to wash out.

The easiest way to make a solution is to tie the hypo crystals up in a cloth or piece of Canton flannel, and suspend in a vessel of hot water. This obviates any necessity for filtering the solution.

Plain bath.—

Hypo	400 g	6½ oz.
Hot water to	1000 ccm	16 oz.

Alkaline bath.—Generally used for silver printing-out images:

Hypo	125 g	2½ oz.
Sodium carbonate, dry	7 g	¼ oz.
Salt	7 g	¼ oz.
Water	1000 ccm	16 oz.

Sodium sulphite, dry, may be substituted for the carbonate.

Acid bath.—

Hypo	150 g	2½ oz.
Potassium metabisulphite	25 g	½ oz.
Water	1000 ccm	16 oz.

This is about the correct strength for papers; for negative work the hypo should be increased to 400 g (6½ oz.). An equally efficient bath is made as follows:

Hypo	400 g	6½ oz.
Citric acid	30 g	230 gr.
Sodium sulphite, dry	35 g	270 gr.
Hot water to	1000 ccm	16 oz.

Dissolve the hypo in half the water and the acid and sulphite in one-fourth, mix the solutions and make up to bulk.

Acid-alum bath.—The following is typical of the formulas recommended by plate and film makers:

Hypo	250 g	16 oz.
Water	1000 ccm	64 oz.

Dissolve and add:

Sodium sulphite, dry	31 g	½ oz.
Acetic acid, No. 8	186 g	3 oz.
Alum	31 g	½ oz.
Water	312 ccm	5 oz.

Dissolve the chemicals in this order. Some paper makers recommend the same bath, but with double the quantity of sulphite and alum, for developed prints.

Acid-chrome alum bath.—

Sodium sulphite, dry	45 g	¾ oz.
Water	100 ccm	1½ oz.

Stir well and add:

Glacial acetic acid	20 ccm	154 min.
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Then add to the following, after the hypo is dissolved:

Hypo	400 g	6½ oz.
Hot water	600 ccm	9 oz.

Finally, add:

Chrome alum	20 g	154 gr.
Hot water	50 ccm	$\frac{3}{4}$ oz.

Make the total bulk up to 1000 ccm or 16 oz.

Rapid ammonia fixing bath.—It is frequently recommended to add ammonium chloride to the fixing bath on the supposition that ammonium hyposulphite is formed, that this fixes quicker, and is washed out more easily. If a 20 per cent solution of hypo is used, the addition of from $2\frac{1}{2}$ to 5 per cent of ammonium chloride increases the rapidity of fixing. With a 40 per cent solution, it has no effect. The addition of 10 per cent of ammonia water to a 20 per cent solution of hypo acts as quickly as the ammonium chloride.

RESIDUES.—To precipitate metallic silver from old hypo baths, from 6 to 8 g per liter (420 to 560 grains per gallon) of sodium hydrosulphite, $\text{Na}_2\text{S}_2\text{O}_4$, should be added, with about half the quantity of caustic soda, and the bath heated to boiling to decompose excess of hydrosulphite. This treatment regenerates the hypo, and the bath can be used again.

Addition of a saturated solution of sulphurated potash, the so-called liver of sulphur, may be used for precipitating the silver from old hypo baths. This should be done out of doors, as sulphuretted hydrogen is evolved. The mixture should be well stirred and the silver sulphide allowed to settle down; then some of the clear supernatant liquid should be collected in a graduate, and tested with a drop or two of liver of sulphur solution. A deep brown colour or blackish precipitate shows the presence of silver in solution, and then more sulphur compound should be added.

A much more cleanly precipitant is zinc. This can be used either in scrap or mossy form. The liquid should be well stirred and allowed to settle; this operation should be repeated three times at intervals of 24 hours. The clear liquid

may be tested as suggested above. About three days is sufficient, as a rule, to throw down the whole of the silver.

One of the best methods of regaining the silver is to procure a sheet of brass, not too thin, and place in the barrel or jar at an angle, so that both sides are presented to the liquid. After about 48 hours, the whole of the silver will be precipitated in the metallic form on the brass and can usually be removed by bending a corner sharply two or three times, when the silver will spring off. The brass can then be put back into the vessel and allowed to remain another 24 or 48 hours, when practically the last trace of silver will be extracted. This thin coat is difficult to remove and may be left on until the next batch of residues is to be treated.

Paper and print clippings and waste prints should be burnt, and the ashes collected and mixed with the silver sulphide from the old fixing baths.

Platinum Residues.—The developer and acid fixing baths from the platinotype process should be collected and preferably boiled down to about one-fourth the volume. Then some saturated solution of ferrous sulphate should be added, the mixture boiled for an hour, and the platinum filtered out.

Gold baths.—Old gold toning baths may be treated in the same way as the platinum solutions, after acidulating with hydrochloric acid.

It does not pay a photographer to refine his own residues. All the silver residues should be mixed together, and the gold and platinum kept separate, and sent to a refiner, who will allow market value of the metals minus a small charge for refining.

HYPO ELIMINATORS.—It is an open question whether the use of chemicals to destroy the last traces of hyposulphite of soda and the hyposulphites of silver is justifiable if permanency of results be the aim. Their action is probably in most

cases to convert these salts into tetrathionates; and, as a negative or print can be practically freed from hypo in half an hour by proper washing, their use is only allowable in cases of great pressure of time or shortage of fresh water. The following have been recommended.

Zinc hypochlorite (Hart).—

Chloride of lime	10 g	77 gr.
Water	500 ccm	8 oz.

Rub the lime into a cream with a little water; then add the rest of the water, and add to:

Zinc sulphate	20 g	154 gr.
Water	500 ccm	8 oz.

Shake well and filter or allow to stand until the precipitate subsides, and decant the supernatant liquid. For use dilute with 9 parts of water; immerse the negatives or prints for about 3 minutes, and then briefly wash and dry. Sodium or potassium hypochlorites may be made and used in the same way, employing the alkaline carbonates instead of the zinc salt.

Potassium permanganate, in 1 per cent solution, may also be used, enough being added to water to give a pink tinge, and the negatives bathed in the solution until the colour is no longer discharged, repeated baths being used. Potassium percarbonate in 1 per cent solution has also been sold commercially as Hypax or Hypono. Sodium perborate can be used in the same way. Potassium or ammonium persulphate in 1 per cent solution, made alkaline with ammonia, may also be used. The former has been sold as Thioxydant, Anthion, etc. A 5 per cent solution of hydrogen peroxide may also be used.

HARDENING BATHS.—Sometimes used for negatives and prints in hot weather. Thorough washing so as to eliminate all hypo must precede these baths:

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- A. Alum 10 per cent solution, or
- B. Chrome alum 2 per cent solution, or
- C. Formaldehyde 10 per cent solution

With the last bath, freedom from hypo is not so essential. Practically, the use of these baths has been rendered obsolete by the use of the chrome alum fixing baths.

CLEARING BATHS.—These baths are not much used at the present day when the use of sulphite and the newer developers prevents the staining of the gelatine, which was so prone to occur in the early days of the gelatine plate, when plain pyrogallol developer was used. The well-washed negatives may be immersed in:

Potassium permanganate	1 g	7.7 gr.
Water	1000 ccm	16 oz.

for 5 minutes, then rinsed in water and immersed in a 1 per cent solution of potassium metabisulphite, or sodium bisulphite, or in:

Alum	200 g	3 oz.
Citric acid	65 g	1 oz.
Water	1000 ccm	16 oz.

Or:

Alum	50 g	$\frac{3}{4}$ oz.
Citric acid	50 g	$\frac{3}{4}$ oz.
Ferrous sulphate	150 g	$2\frac{1}{4}$ oz.
Water	1000 ccm	16 oz.

Or:

Chrome alum	25 g	192 gr.
Sodium bisulphite	100 g	770 gr.
Water	1000 ccm	16 oz.

Or:

Thiocarbamide	20 g	154 gr.
Citric acid	10 g	77 gr.
Water	1000 ccm	16 oz.

Intensification

THE MERCURY INTENSIFIER.—This is probably the most generally used of all intensifiers. The silver image is treated with mercuric chloride or bromide until bleached, then washed, and blackened by various reagents. The mercuric halide solution is sensitive to light and should be kept in the dark. It is extremely poisonous when taken internally, but the absorption by the skin, even in the case of cuts and abrasions, is practically harmless. Make up the following mercury solution:

Mercuric chloride	20 g	154 gr.
Salt	20 g	154 gr.
or Ammonium chloride	20 g	154 gr.
or Hydrochloric acid	3 ccm	23 min.
or Potassium bromide	20 g	154 gr.
Water	1000 ccm	16 oz.

The purpose of these additions is to increase the solubility of the mercury salt, and the bromide gives greater increase of density than the others. The plate to be intensified should be perfectly free from hypo, and if dry, soaked in water for 10 minutes, and then immersed in the mercury solution until the image seen from the back is white; on no account should the action be stopped before this point is reached. It should then be well washed in water acidulated with hydrochloric acid, 1:300; about 5 minutes soaking in six successive baths may be used; then, after washing in running water for 10 minutes, it may be blackened. The acid bath removes the mercury salt, which is tenaciously held by the gelatine, and might otherwise give rise to stains. This acid treatment may be avoided by the use of the following bleach:

Mercuric chloride	20 g	154 gr.
Ammonium chloride	150 g	2 oz., 192 gr.
Hydrochloric acid	10 g	77 gr.
Water	1000 ccm	16 oz.

The large proportion of the ammonium chloride is said to facilitate the removal of the mercury salt.

The blackening may be effected with one of the following reagents:

A. Ferrous oxalate developer, using 1 part of iron sulphate solution to 6 of oxalate;

B. Amidol developer. Other developing agents with sulphite may be used;

C. Sodium sulphite, 5 per cent solution of the anhydrous or 10 per cent solution of the hydrated salt;

D. Ammonia, 10 per cent solution of the strongest ammonia water. The bromide bleach does not give such satisfactory results with this as the chloride;

E. Silver-potassio-cyanide (Monckhoven). This is prepared from:

I. Silver nitrate	20 g	154 gr.
Water	500 ccm	8 oz.
II. Potassium cyanide	20 g	154 gr.
Water	500 ccm	8 oz.

Add three-fourths of I to II and shake thoroughly; a thick curdy white precipitate will be thrown down, which dissolves on shaking. If a perfectly clear solution is obtained, add more I until, after shaking and allowing to stand with occasional agitation for 10 minutes, there is a permanent white precipitate. The quantity of silver required depends on the strength of the cyanide, which varies considerably; in any case, a permanent deposit must be formed, even by adding more silver than above stated. This method of mixing is better than adding the cyanide to the silver. If the negatives

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are allowed to remain too long in this solution, they are reduced;

F. Mercuric-iodo-cyanide (Eder):

Potassium cyanide	5 g	38 gr.
Potassium iodide	2.5 g	19 gr.
Mercuric chloride	2.5 g	19 gr.
Water	1000 ccm	16 oz.

The bleached image first turns yellowish, then dark brown, and, if the plate be removed at this stage, it will generally be too dense for practical purposes; if the action is allowed to continue longer, the image turns a lighter brown and becomes more transparent;

G. Schlippe's salt or sodium sulphantimoniate:

Schlippe's salt	25 g	192 gr.
Ammonia	10 ccm	77 min.
Water	1000 ccm	16 oz.

Make just before use and filter. Gives a brownish-red image which is too dense for ordinary work. This is useful for restoring negatives intensified with mercury, which have faded with course of time;

H. Sodium sulphide	10 g	77 gr.
Water	1000 ccm	16 oz.

Usually gives too much intensification for ordinary work;

I. Formalin with caustic soda has been recommended for blackening the bleached images, but presents no advantage;

J. Stannous tartrate (Helain):

Stannous chloride	20 g	154 gr.
Tartaric acid	20 g	154 gr.
Water	1000 ccm	16 oz.

This has also no special features to recommend it.

Practically, it may be said that, assuming the original density of the negative to be 1, the intensification given by A, B, C, E will be 2, by D about 2.5. Repeated bleaching with

mercury and development with ferrous oxalate will give any desired degree of increase.

Mercuric Iodide (Edwards, Lumière, etc.)—As originally recommended by Edwards, this was a solution of mercuric iodide in excess of iodide and hypo, as follows:

Mercuric chloride	12 g	92 gr.
Water	650 ccm	10 oz.

Dissolve and add:

Potassium iodide	33 g	253 gr.
Water	100 ccm	2 oz.

And, finally:

Hypo	27 g	207 gr.
Water	250 ccm	4 oz.

MM. Lumière suggested:

Mercuric iodide	10 g	77 gr.
Sodium sulphite, dry	100 g	770 gr.
Water	1000 ccm	16 oz.

This is an improvement on the first formula. The negatives assume a dark brown colour, but the image is not stable and soon turns yellow. It is advisable, therefore, to treat the darkened image with a developer, which renders it permanent. Welborne Piper proposed the following:

A. Mercuric chloride	50 g	384 gr.
Hot water	1000 ccm	16 oz.
B. Potassium iodide	50 g	384 gr.
Cold water	250 ccm	4 oz.

Add B to A gradually, shaking after each addition until the solution becomes clear, and, if necessary, heating. After all B has been added and the solution is clear, allow to cool and filter out any red precipitate formed. The negatives should be bleached in this solution, washed and treated with sodium sulphite or ammonia, or redeveloped, and well washed.

Mercuric Sulphocyanide (Agfa).—This was patented in

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Germany by the Aktiengesellschaft f. Anilinfabrikation. A similarly acting solution can be made as follows:

Mercuric chloride	187 g	3 oz.
Hot water	750 ccm	12 oz.

Add:

Ammonium sulphocyanide	225 g	3 oz., 262 gr.
Water	250 ccm	4 oz.

For use dilute 1 part with 10 parts of water. The negative turns black at once; but, if left too long, the intensification is reduced. The images are not stable unless a developer is applied.

THE CHROMIUM INTENSIFIER (*Eder, Welborne Piper and Carnegie*).—This method of intensification has deservedly received considerable attention, being less liable to stain and much less poisonous than many others. The negatives need not be absolutely free from hypo, as the bleaching bath oxidises this, though, if much hypo be present, it may be necessary to apply the bleaching bath twice. Two stock solutions are required:

I. Potassium bichromate	50 g	384 gr.
Water	1000 ccm	16 oz.
II. Hydrochloric acid, pure	100 ccm	1 oz.
Water	1000 ccm	10 oz.

The bleaching baths are:

	A	B	C
Stock solution I	32	64	64 parts
Stock solution II	3	16	64 parts
Water	128	80	32 parts

Immerse the negative in the solution until the image on the glass side appears bleached, then wash until the yellow stain is removed, and develop with amidol in white light. Other developers may be used, without bromide, but the image requires exposure to diffused daylight, and they are less

satisfactory. A gives the strongest and C the least intensification. The process may be repeated as often as required. As a variant the following may be used:

Chromic acid	2.5 g	19.2 gr.
Salt	2.5 g	19.2 gr.
Water	1000 ccm	16 oz.

The procedure described above should be followed. The acid and salt may be kept in stock solutions, say 10 per cent, and mixed as required.

A convenient form of a dry salt, the chlorochromate, may be prepared as follows (Lumière & Seyewetz):

Ammonium bichromate	82 g	1265 gr.
Hydrochloric acid,		
sp. gr. 1.16	364 ccm	12 oz., 160 min.

Place the acid in an evaporating dish, add the ammonium salt, and evaporate until dry. The result will be 100 g (1543 gr.) of ammonium chlorochromate, which may be kept in a dry state or in a 10 per cent solution by dissolving in 1000 ccm (32 oz.) distilled water. Of this, 30 ccm (210 min.) should be diluted to 1000 ccm (16 oz.) to form a convenient bleacher. The equivalent weights of the potassium salt may be used, that is, 100 g or 1543 gr.

THE COPPER-SILVER INTENSIFIER.—This intensifier is particularly valuable for black and white or line negatives, and gives great intensification. The bleaching solution is prepared from:

I. Cupric sulphate	115 g	2 oz.
Hot water	500 ccm	8 oz.
II. Potassium bromide	115 g	2 oz.
Hot water	500 ccm	8 oz.

Mix and allow to cool. The negative should be bleached in this, washed no longer than 2 minutes, and blackened in:

Silver nitrate	10 per cent solution
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If still greater density be required, the negative should be well washed after bleaching and redeveloped with any ordinary developer, the silver treatment being omitted. Or, after washing, the negative may be blackened with a 0.5 per cent solution of sodium sulphide.

As an improvement on the silver nitrate, which may cause stains, Namias recommends silver oxalate. To prepare this, take:

Silver nitrate	10 g	77 gr.
Water	100 ccm	2 oz.

Dissolve, and add:

Potassium oxalate, neutral	6 g	46 gr.
Water	50 ccm	1 oz.

Allow the silver oxalate to settle down, decant the water, and add the precipitate to 1000 ccm (16 oz.) water. Shake the solution every time before applying to the bleached negative. The process is applicable to papers as well as plates, and it is advisable to subsequently immerse in a 10 per cent solution of hypo for a few minutes and wash well.

THE COPPER-TIN INTENSIFIER.—In this the final image consists of a mixture of tin and silver compounds, and the intensification is due to a great extent to the non-actinic colour of the deposit, which is a warm brown. Bleach the negative in:

Cupric chloride	30 g	230 gr.
Hydrochloric acid	3 ccm	23 min.
Water	1000 ccm	16 oz.

Wash thoroughly and immerse in the following:

Stannous chloride	40 g	307 gr.
Water	400 ccm	4 oz.

To which is added:

Caustic soda	30 g	230 gr.
Water	100 ccm	1 oz.

This should be added cautiously to the tin solution, with constant stirring, so that the precipitate first formed is not quite cleared up. The solution should then be filtered, and the bulk made up to 1000 ccm (16 oz.) with water. A variation of this method is to treat the bleached image with a 5 per cent solution of caustic soda, wash, and then with 10 per cent of stannous chloride. The cupric chloride may be replaced by:

Cupric sulphate	4.4 g	34 gr.
Salt	20.8 g	160 gr.
Hot water	1000 ccm	16 oz.

Mix and allow to cool before use.

COPPER FERROCYANIDE INTENSIFIER.—This is very rarely used, and is apt to give too great intensification. The degree of increase depends on the duration of the action of the bath and the consequent warmth of colour. Two stock solutions are required:

I. Cupric sulphate	7 g	54 gr.
Potassium citrate, neutral	28 g	215 gr.
Water	1000 ccm	16 oz.
II. Potassium ferricyanide	6 g	46 gr.
Potassium citrate, neutral	28 g	215 gr.
Water	1000 ccm	16 oz.

Mix in equal quantities just before use. No. II solution must be kept in the dark. A variation of this is to mix the two solutions and to add enough strong ammonia to form a clear solution.

THE URANIUM INTENSIFIER.—Except for extremely thin and flat negatives, this is not to be recommended. The degree of intensification depends upon the ratio of the uranium to the ferricyanide:

I. Uranium nitrate	100 g	768 gr.
Glacial acetic acid	40 ccm	300 min.
Water	1000 ccm	16 oz.

II. Potassium ferricyanide	40 g	307 gr.
Potassium oxalate	10 g	77 gr.
Glacial acetic acid	40 ccm	300 min.
Water	1000 ccm	16 oz.

If mixed in equal volumes, a reddish brown image is obtained; 1 part I and 2 parts II give a reddish image; 5 parts I and 1 part II give a brown. The colour is also dependent to some extent on the duration of the action of each bath. The negatives should be washed in a 2 per cent solution of citric acid, or 1 per cent oxalic or glacial acetic acid. If plain water be used, about five changes at intervals of 5 minutes are enough. Prolonged washing in running water will completely remove the intensification, generally first in patches.

THE LEAD INTENSIFIER.—This gives very great intensification and is only suitable for black and white line work:

Lead nitrate	46 g	353 gr.
Potassium ferricyanide	70 g	537 gr.
Glacial acetic acid	20 ccm	154 min.
Water	1000 ccm	16 oz.

This will keep in the dark. The lead salts are rather tenaciously retained by the gelatine; it is advisable to immerse the negatives in a 5 per cent solution of nitric acid for 5 minutes, and then wash. If the negative be subsequently developed, rather less intensification is given. By applying a 10 per cent solution of chromic acid to the bleached negative, an orange image is obtained, which is very non-actinic, and the lines remain clear. Treatment with a 2 per cent sodium sulphide solution gives the greatest increase.

QUINONE INTENSIFIER (*Lumière*).—This has not come into general use, and the intensification is practically dependent on a change of colour of the image into a more non-actinic one; but some compound of silver and bromine is present.

A. Quinone	5 g	38 gr.
Potassium bromide	25 g	192 gr.
Water	1000 ccm	16 oz.

Or:

B. Sodiumquinone sulphonate	10 g	77 gr.
Potassium bromide	25 g	192 gr.
Water	1000 ccm	16 oz.

The negative after treatment may look muddy. It should be briefly rinsed with water, and immersed in a 10 per cent solution of ammonia. The colour given by A is reddish brown, by B yellowish brown. Ammonia, with short action, gives great intensification, both images becoming dark brown; after 10 minutes' action, the original colours are again formed with less intensification. The carbonates of sodium and potassium also turn the images brown, giving also great intensification. Hypo reduces the image without altering the colour of plates treated with A, but with B the final colour is a reddish-yellow. Sulphites or bisulphites convert the image of A into a greenish-brown; in the case of B, into a dark brown. An amidol developer acts like sulphite on A, but gives yellowish-black images with B.

BROMO-IODIDE OF COPPER (*Jenney*).—

Cupric sulphate	37.5 g	288 gr.
Water	500 ccm	8 oz.

When dissolved, add:

Potassium iodide	9 g	69 gr.
Potassium bromide	23 g	177 gr.
Water	500 ccm	8 oz.

A slight precipitate of copper iodide is formed, which should be filtered out. The negative should be immersed in the solution until bleached to a bright yellow colour, which takes from 5 to 15 minutes, and then well washed and immersed in a saturated solution of sodium sulphite to which a few

grains of silver nitrate have been added. This gives a brownish-black image. By applying a hydrochinon developer, a reddish image is obtained, and rodinal gives a brown. After intensification, the negative or print should be well washed in water. Both bleaching and redevelopment should be carried out in bright daylight. This is very rarely used and presents no particular advantages.

DYE INTENSIFICATION.—Partially bleach the images in :

Potassium ferricyanide	0.34 g	2.5 gr.
Ammonium bichromate	0.068 g	0.5 gr.
Glacial acetic acid	8.5 ccm	64 min.
Water	1000 ccm	16 oz.

Then wash, and immerse in :

Victoria green	0.26 g	1.25 gr.
Safranin	0.52 g	2.5 gr.
Glacial acetic acid	8.5 ccm	64 min.
Water	1000 ccm	16 oz.

Dye for 30 to 120 seconds and wash for 5 minutes.

Reducers

POTASSIO-FERRIC OXALATE (*Belitzski*).—A very convenient reducer, which may be kept as a stock solution in the dark, and repeatedly used until it turns yellow, which is a sign of exhaustion:

Potassium ferric oxalate	50 g	384 gr.
Water	1000 ccm	16 oz.

Dissolve, and add:

Sodium sulphite, dry	20 g	154 gr.
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This forms a blood red solution, to which should be added:

Oxalic acid, cryst.	15 g	115 gr.
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Shake the solution until a bright green colour is formed, free from any tinge of yellow; then pour off from any undissolved crystals, and add:

Hypo	250 g	4 oz.
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Shake until dissolved.

It is preferable to soak the negative in water before applying the reducer. Thorough washing should follow the reduction. Instead of the potassium ferric oxalate, the following may be used:

Ferric chloride	32.5 g	500 gr.
Neutral potassium oxalate	62.5 g	950 gr.

This will make the above quantity of potassium ferric oxalate, and the potassium chloride formed is negligible. The reducer tends to attack the shadows more than the high-lights, therefore, increases contrasts.

HYPOCHLORITE AND ALUM (*Debenham*).—An excellent reducer, which can be locally used by immersing the negative in the solution and rubbing any part with a pad of absorbent cotton:

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Chloride of lime	6 g	46 gr.
Make into a paste with a little water, and add to:		
Sodium carbonate, dry	4.5 g	34 gr.
Water	250 ccm	4 oz.

Shake thoroughly, filter, and wash the filter with successive portions of water to make the total bulk of the filtrate 1000 ccm (16 oz.), then add:

Chrome alum	4 g	30 gr.
Immerse the negative and rock the dish for a few minutes; then gently pass a pad of absorbent cotton, well wetted, over the surface.		

BICHROMATE.—

Potassium bichromate	20 g	154 gr.
Sulphuric acid	40 ccm	308 min.
Water	1000 ccm	16 oz.

Dissolve the bichromate, and add the acid. This has nothing particular to recommend it, and requires rather long washing to remove the yellow stain from the negative.

PERMANGANATE (*Namias*).—

Potassium permanganate	0.5 g	4 gr.
Sulphuric acid	10 ccm	77 min.
Water	1000 ccm	16 oz.

It is preferable to mix this just before use, or stock solutions can be prepared by dissolving the permanganate in half the water, and the acid in the other half; the stock permanganate solution must be kept in the dark. This reducer acts evenly and can be used for prints as well as negatives. Should any brown stains appear, they may be removed by immersing the plates or prints in:

Sodium sulphite, dry	75 g	576 gr.
Oxalic acid	30 g	230 gr.
Water	1000 ccm	16 oz.

Wash well after this bath.

IODIDE AND HYPO (*Lainer*).—An extremely slow acting reducer, which is useful in the case of negatives generally fogged:

Potassium iodide	10 g	77 gr.
Hypo	250 g	4 oz.
Water	1000 ccm	16 oz.

The negative should be immersed in this solution for from 8 to 10 hours, or until the desired reduction is attained, then well washed. Prints may also be reduced in the same way.

CERIC SULPHATE (*Lumière*).—

Sulphuric acid	4 ccm	30 min.
Water	200 ccm	3 oz.

Add:

Ceric sulphate	10 g	77 gr.
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Stir until dissolved, then add:

Water to	1000 ccm	16 oz.
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For use mix 1 part with 9 parts of water. This reduces the contrasts, and the negatives should be well soaked in water prior to immersion in the solution. For overexposed dense negatives, mix the above stock solution with an equal volume of water, and immerse the negative dry; care must be exercised, as the action is very rapid. There is no liability to stain, and the solution may be used still more dilute for prints.

IDO-CYANIDE.—Extremely poisonous, but clean acting:

Iodine	6 g	46 gr.
Potassium iodide	18 g	138 gr.
Water	30 ccm	$\frac{1}{2}$ oz.

Rub the iodine and the iodide together in a mortar or graduate with a glass rod, add the water, and stir until complete solution is obtained; then add:

Water	970 ccm	15½ oz.
Potassium cyanide	1 g	7.7 gr.

This forms an excellent non-staining reducer for developed prints if diluted with 10 times its volume of water.

MERCURY AND CYANIDE (*Eder*).—An extremely poisonous but non-staining reducer:

Mercuric chloride	2.5 g	19 gr.
Water	1000 ccm	16 oz.

Dissolve, and add:

Potassium iodide	2.5 g	19 gr.
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Red mercuric iodide is precipitated, which is dissolved by the addition of:

Potassium iodide	5 g	38 gr.
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This acts rapidly. It is suitable for developed prints if diluted with 10 parts of water. A variant of this is to replace the iodide with a like quantity of sodium carbonate crystals.

CUPRIC CHLORIDE (*Spiller*).—

A. Alum	100 g	1¾ oz.
Cupric chloride	100 g	1¾ oz.
Salt	200 g	3½ oz.
Hot water	1000 ccm	16 oz.

Dissolve, and filter when cold.

B. Saturated solution of salt.

For use mix in equal volumes. When the negative is nearly sufficiently reduced, wash. This cannot be recommended, as the reducing action continues too much during the washing. A variation of the above (Fourtier) has been suggested:

Cupric sulphate	5 g	38 gr.
Water	100 ccm	2 oz.

Dissolve, and add solution of potassium carbonate until no further precipitate is formed. Collect the precipitate on a filter, wash with several changes of water, and then dissolve in:

Hydrochloric acid	q. s.	
Water	25 ccm	½ oz.

Enough acid should be used to dissolve the precipitate. To the clear solution add:

Ammonia	q. s.
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This forms a deep blue, clear solution to which should finally be added:

Hypo	5 g	38 gr.
Water to	1000 ccm	16 oz.

This is said to be particularly useful for local reduction of prints. The print should be well soaked in water, placed face up on a sheet of glass, and the reducer applied with a pad of absorbent cotton. The action is at once stopped by well washing with water. This has been but little used in practice, and the method of making is a roundabout way of making cupric chloride. An easier way would be to mix:

Cupric sulphate	5 g	38 gr.
Salt	2.35 g	18 gr.
Water	100 ccm	2 oz.

then add enough ammonia to form a clear solution.

Ferric chloride and sulphate either alone or with citric acid have been recommended as reducers; but they are extremely liable to stain the gelatine by the deposition of basic iron salts and should not be used.

HYPONITRIDE (Farmer).—This is prepared as wanted by adding a little 10 per cent solution of potassium ferricyanide to a 20 per cent plain solution of hypo. The quantity of ferricyanide to be added depends on the result desired; the weaker the solution, the more even the action, that is to say, the less the shadows are attacked. A pale yellow coloured mixture is best. The colour of the solution rapidly disappears in use, and this is a sign of exhaustion. A fresh mixture should be applied rather than allow an old one to act. The action of this bath is the conversion of some of

the silver into silver ferrocyanide, which dissolves in the hypo.

Homolka suggested as a stable reducer:

Potassium ferricyanide	50 g	384 gr.
Sodium amido-acetate	200 g	3 oz., 224 gr.
Water	1000 ccm	16 oz.

For use dilute with from 5 to 10 parts of water, and, when the desired reduction is attained, immerse the negative in an acid fixing bath.

Another modification of Farmer's reducer is the following (Haddon), which has the advantage of keeping well:

Potassium ferricyanide	10 g	77 gr.
Ammonium sulphocyanide	20 g	154 gr.
Water	1000 ccm	16 oz.

The negative should be soaked in water before immersion.

AMMONIUM PERSULPHATE.—The particular value of this reducer is that it attacks the densest parts of a negative more than the shadows, thus considerably reducing contrasts; but its action is much complicated by intentional or accidental additions, such as acid, chlorides, and iron salts, which may occur by keeping the solution or the use of ordinary tap water. A 5 per cent solution in distilled water should be made, and allowed to stand for 3 to 4 hours, or 15 ccm (105 min.) of 10 per cent solution of sulphuric acid, or 1 ccm (8 min.) of 5 per cent solution of ammonia iron alum added per liter (16 oz.). The following solution has been advised (Bennett), and can be kept for a considerable time in stock:

Ammonium persulphate	125 g	2 oz.
Sodium sulphite, dry	10 g	77 gr.
Sulphuric acid	10 g	77 min.
Water	1000 ccm	16 oz.

For use dilute with from 4 to 8 parts of water, according to

the rapidity of action desired. Immersion in a 5 per cent solution of sodium sulphite has been recommended as a stop bath, but this is liable to cause red stains. The best plan is to wash rapidly.

The following mixture (Puddy) acts on the shadows before the high-lights:

Ammonium persulphate	50 g	384 gr.
Ammonium sulphocyanide	25 g	192 gr.
Water	1000 ccm	16 oz.

The following solution acts on all densities nearly alike:

A. Potassium permanganate	0.25 g	1.92 gr.
Sulphuric acid, 10% solution	15 ccm	115 min.
Water	1000 ccm	16 oz.
B. Ammonium persulphate	25 g	192 gr.
Water	1000 ccm	16 oz.

For use mix 1 part A with 3 parts B. The separate solutions keep well, but should not be mixed until required. The time of reduction varies from 1 to 3 minutes, and greater control is obtained by diluting the mixture with an equal volume of water. As soon as the desired reduction is reached, immerse the negative in a 1 per cent solution of potassium metabisulphite for 5 minutes, and wash.

QUINONE REDUCER (*Lumière*).—This acts like ammonium persulphate, that is, reduces the high-lights more than the shadows:

Quinone	5 g	38 gr.
Sulphuric acid	20 ccm	154 min.
Water	1000 ccm	16 oz.

As soon as the desired reduction is reached, the plate should be immersed in a 2 per cent solution of sodium bisulphite, washed, and dried.

HARMONISING HARSH NEGATIVES.—This method of reducing the over-dense parts of negatives has been replaced by

the use of the persulphate, but it is still valuable. The negative should be immersed in:

Hydrochloric acid	25 ccm	192 min.
Potassium bichromate	8 g	61 gr.
Alum	40 g	307 gr.
Water	1000 ccm	16 oz.

Leave until bleached through to the glass, then thoroughly wash until all traces of yellow disappear. It should then be developed with a slow acting developer, such as hydrochinon, about one-fourth the usual strength, and development continued until, on examination of the negative from the glass side, it is seen that the shadows and half tones are fully developed, while the high lights still show white silver chloride. The negatives should then be fixed and washed. This method is also useful for halated negatives. The following modified bleacher may be used:

Chromic acid	5 g	38 gr.
Potassium bromide	10 g	77 gr.
Water	1000 ccm	16 oz.

The method of using is as above, or, to hasten the removal of the yellow stain, apply a 2.5 per cent solution of potassium metabisulphite or sodium bisulphite.

MECHANICAL REDUCTION.—This is a method but little practiced and rather dangerous, except in expert hands. It consists in local attrition of the gelatine, preferably with a chamois leather moistened with denatured alcohol (methylated spirit). Another abrasive has also been suggested (Baskett), and consists of a mixture of equal parts of terebene, olive oil, and metal polish. This is also used with chamois leather, and acts more quickly than the alcohol. After its use, the negative should be rubbed two or three times with benzol to remove the grease. Some commercial metal polishes may be used without any admixture, but, after shaking well, should be

allowed to stand for a minute or two for the coarser particles to subside.

Varnishes

VARNISHES.—The increasing use of bromide and development papers instead of printing-out papers, and, in a minor degree, the general adoption of films by amateur workers, has rendered less obligatory the use of negative varnishes for the protection of the gelatine surface. In the case of celluloid films, it is obvious that the solvents used in the varnishes must not attack the celluloid; therefore, the aqueous varnishes are preferred, though they do not give so much protection as the others. Varnishes may be classified as “hot” and “cold” varnishes, the former being applied to a heated negative, while the latter may be applied to the cold negative. In the first case, the negatives should be warmed in front of a fire or over a gas or spirit burner until the glass is as hot as the back of the hand can comfortably bear.

HOT VARNISHES.—

Orange shellac	75 g	576 gr.
Gum sandarac	75 g	576 gr.
Alcohol, 96%	1000 ccm	16 oz.
Castor oil	2 ccm	15 min.

Allow the mixture to stand with frequent shaking until the resins have dissolved; then filter. There is frequently some trouble in clarifying varnishes, as the fine insoluble particles will not easily filter out. The remedy is to add about 2 per cent by weight of some inert powder, such as finely powdered pumice stone or tripoli, shake well, and filter. Another formula:

Orange shellac	50 g	384 gr.
Gum elemi	15 g	115 gr.
Alcohol	1000 ccm	16 oz.

Or:

Gum mastic	8 g	61 gr.
Ether	250 ccm	5 oz.
Gasoline	750 ccm	11 oz.

Not advisable, as the vapours are very explosive when mixed with air. Another:

Gum sandarac	100 g	768 gr.
Camphor	10 g	77 gr.
Venice turpentine	10 g	77 gr.
Oil of lavender	20 ccm	154 min.
Alcohol	1000 ccm	16 oz.

Or:

Orange shellac	200 g	1536 gr.
Gum sandarac	50 g	384 gr.
Gum mastic	5 g	38 gr.
Gum dammar	5 g	38 gr.
Castor oil	5 ccm	38 min.
Alcohol	1000 ccm	16 oz.

COLD VARNISHES.—Aqueous shellac varnish (Water-house):

Orange shellac	80 g	614 gr.
Borax	20 g	154 gr.
Sodium carbonate, cryst.	20 g	154 gr.
Glycerine	5 ccm	38 gr.
Water	1000 ccm	16 oz.

Dissolve the borax and soda in half the water, add the shellac, and boil until dissolved; then add the glycerine and enough water to make the total bulk, and filter when cold.

Or:

Bleached shellac	100 g	1 3/5 oz.
Borax	25 g	192 gr.
Sodium carbonate, cryst.	6 g	46 gr.

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Glycerine	3 ccm	23 min.
Water	1000 ccm	16 oz.
The method of making is as above. Or :		
Bleached shellac	150 g	2 2/3 oz.
Alcohol	300 ccm	5 1/3 oz.
Dissolve, and add :		
Ammonia	225 ccm	4 oz.
Glycerine	7 ccm	54 min.
Warm water	1000 ccm	16 oz.

The above are particularly suitable for films. When using bleached shellac, it is essential to procure freshly bleached lac, or that which has been kept under water, as, when exposed to the air, this loses its solubility to a great extent. Dichlorhydrin is an excellent solvent for bleached shellac, when warmed, but this varnish cannot be used for films, as it dissolves the celluloid.

An excellent varnish (Valenta) is made as follows :

Gum dammar	75 g	576 gr.
or Gum mastic	60 g	460 gr.
Carbon tetrachloride	1000 ccm	16 oz.

If the mastic is used, it is necessary to heat to obtain perfect solution. Both varnishes give hard surfaces, which take retouching well.

Epichlorhydrin and dichlorhydrin have also been recommended (Valenta) as solvents for varnishes, but have found little use. The following are suitable formulas :

Copal	20 g	154 gr.
Epichlorhydrin	70 ccm	1 oz.
Digest on a water bath until dissolved, and add :		
Alcohol	770 ccm	11 oz.
Epichlorhydrin	160 ccm	4 oz.

Then filter. This gives a very hard film that dries quickly,

may be used either as a hot or cold varnish, and takes the retouching pencil well.

MATT VARNISHES.—These are generally used on the backs of negatives either to hold back certain parts in printing, or to facilitate working up with pencil or crayon:

Gum sandarac, powdered	53 g	400 gr.
Gum dammar	16 g	120 gr.
Ether	700 ccm	11¼ oz.

Allow to stand with frequent shaking until dissolved, then filter, and add:

Benzol	300 ccm	4¾ oz.
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and:

Alcohol	1 to 5 ccm	7 to 35 min.
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The quantity of alcohol determines to some extent the fineness of the matt grain. The following may also be used:

Gum sandarac, powdered	72 g	504 gr.
Ether	715 ccm	11½ oz.

Shake until dissolved, filter, and add:

Toluol	285 ccm	4½ oz.
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This does not give such fine grain as the former.

For celluloid negatives the above varnishes with alcohol-ether solvents are not suitable, as the latter attacks the base. The following is suitable:

Amber	25 g	192 gr.
Benzol	1000 ccm	16 oz.

The amber should be added in fine pieces, and the mixture digested in a warm place for two or three days, with occasional shaking, until the resin dissolves, then filter.

There is frequently trouble when making varnishes, from the gums and resins compacting into a solid mass at the bottom of the bottle. This may be avoided to a great extent by using a wide-mouth bottle and suspending the resins in a little bag of fine muslin at the top of the liquid. As the resins

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dissolve, the solution sinks to the bottom of the bottle, and fresh solvent takes its place. This also frequently obviates the necessity of filtering. Another plan is to mix the resins with coarse glass grains or beads, about half the size of a grain of wheat.

DEVARNISHING NEGATIVES.—Sometimes it becomes necessary to remove the varnish from negatives and this usually can be accomplished by soaking in strong alcohol, and then using gentle friction with a pad of absorbent cotton. It is preferable to use only just enough alcohol to cover the surface of the negative, and to apply two or three successive alcohol baths. A more energetic solvent is a 2 per cent solution of caustic potash, or soda, or ammonia in alcohol, which may be used for the first bath, and then followed by clean alcohol.

PRINT VARNISH.—Sometimes used for brightening up matt surface papers:

Gum sandarac	110 g	1¾ oz.
Benzol	400 ccm	6½ oz.
Acetone	400 ccm	6½ oz.
Alcohol, 90%	200 ccm	3 oz.

Or:

Gum dammar	60 g	1 oz.
Ether	500 ccm	8 oz.
Benzol	500 ccm	8 oz.

These may either be applied with a brush locally to the shadows or the prints floated face downwards on the varnish.

BLACK VARNISH.—

Shellac	200 g	3 1/5 oz.
Denatured alcohol	1000 ccm	16 oz.
Aniline black, spirit soluble	15 g	115 gr.

ALCOHOLIC COLD VARNISHES (*Valenta*).—

Gum sandarac	180 g	1382 gr.
Alcohol, 96%	1000 ccm	16 oz.

Oil of lavender	10 ccm	77 min.
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Or:

Gum sandarac	100 g	768 gr.
Benzol	400 ccm	6½ oz.
Acetone	400 ccm	6½ oz.
Alcohol, 96%	200 ccm	3¼ oz.

CELLULOID OR ZAPON VARNISH.—

Pyroxyline or celluloid scraps	20 g	154 gr.
Amyl acetate	1000 ccm	16 oz.

Allow to stand for some time with frequent shaking until solution take place, and then allow to stand three or four days to settle. This takes a very long time to dry. Or:

Pyroxyline or celluloid scraps	12 g	92 gr.
Amyl acetate	400 ccm	6 oz.
Benzol	400 ccm	6 oz.
Acetone	200 ccm	3 oz.

This is also suitable for prints. A 5 per cent solution of pyroxyline in equal volumes of amyl acetate and alcohol can be used to protect metal work, can be applied either with a brush or spray, and is quite invisible; sometimes butyl acetate is used instead of the amyl compound. Greater adhesion is obtained with the following:

Pyroxyline	37.5 g	288 gr.
Shellac	37.5 g	288 gr.
Amyl acetate	500 ccm	8 oz.
Benzol	250 ccm	4 oz.
Methyl alcohol	250 ccm	4 oz.

The film thus obtained is not so lasting as the plain pyroxyline varnish. Black varnish may be made by incorporating lamp black, when the varnish will be more or less matt, or by the use of spirit-soluble nigrosine, when glossy surfaces will be obtained. Any coloured varnish may be made by dissolving oil-soluble aniline dyes in the solvents.

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CRYSTAL VARNISHES.—These are sometimes used for lantern slides and transparencies:

Gum dammar	125 g	2 oz.
Benzol	1000 ccm	16 oz.

Or:

Fused amber	125 g	2 oz.
Chloroform	1000 ccm	16 oz.

Or:

Fused amber	200 g	3 oz.
Gum sandarac	300 g	4½ oz.
Gum elemi	50 g	384 gr.
Alcohol	1000 ccm	16 oz.
Camphor	6 g	46 gr.

RETOUCHING VARNISHES.—Since the gelatine film, as well as many of the varnishes, will not take kindly to the retouching pencil, it is customary to apply locally a retouching varnish or medium which leaves a surface with a slight tooth. These should be applied in very small quantities, a drop or two, gently rubbed with a circular motion with the finger tip over the part to be retouched, and then allowed to dry:

Gum dammar	20 g	96 gr.
Turpentine, refined	100 ccm	1 oz.

Or:

Powdered resin	12.5 g	60 gr.
Turpentine, refined	100 ccm	1 oz.

Or:

Gum dammar	6.6 g	32 gr.
Turpentine, refined	50 ccm	½ oz.
Benzol	50 ccm	½ oz.
Oil of lavender	50 drops	10 drops

Or:

Gum dammar	20 g	154 gr.
Venice turpentine	10 g	77 gr.

Turpentine	1000 ccm	16 oz.
Nitrobenzol	100 ccm	1 oz., 288 min.

RETOUCHING MEDIUM.—

Pure American turpentine	43 ccm	1½ oz.
Oil of spike	14.2 ccm	½ oz.
Pale resin	28.3 g	1 oz.
Raw linseed oil	0.5 ccm	8 min.
Terebene	1.2 ccm	20 min.
Amyl acetate	7 ccm	¼ oz.

If the solution is too thick, dilute with turpentine. Apply as little as possible with the finger tip.

BLOCKING-OUT MEDIUM.—

Gum sandarac	500 g	8 oz.
Denatured alcohol	1000 ccm	16 oz.

Dissolve by allowing to stand in a warm place with constant stirring, carefully decant from the residue, and add lamp black to give a suitable consistency.

FIXATIVE FOR CRAYON OR PASTEL WORK.—This also forms a good varnish for prints:

Mastic	8.3 g	64 gr.
Amyl acetate	500 ccm	8 oz.

Dissolve with constant stirring, allow to stand some hours to settle, and mix with:

Celluloid	2.5 g	18.5 gr.
Amyl acetate	500 ccm	8 oz.

This should be applied with a spray diffuser.

STRIPPING FILMS.—The film can be easily stripped from negatives by one of the following processes. First, lay the negative face up on a smooth support, and cut right through the gelatine down to the glass with a sharp knife, about one-eighth of an inch from the edges. Then level the plate, and pour on it a little of the following solution:

Glycerine	37.5 ccm	288 min.
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Water	37.5 ccm	288 min.
Hydrofluoric acid	37.5 ccm	288 min.
Denatured alcohol to	1000 ccm	16 oz.

Spread the solution with a brush or spill of paper, and allow to soak for about 5 minutes. Then try and strip the narrow cut edges; if these can be easily removed, the work may be proceeded with; if not, the plate should be left a little longer. When the film is loose, as shown by the above test, pour off the liquid carefully, taking care not to let the film slip. Pour on some of the above solution without the acid, leave for 2 or 3 minutes, and then drain this off. Gently place a piece of smooth waxed paper or thin celluloid over the negative, and lightly squeegee into contact; on lifting the paper, the film will be removed with it, and can be transferred to another support. Great care must be taken in the use of the above solution, as it attacks the fingers and all glass. It is better either to make up the stock solution without the hydrofluoric acid and add this just before use, or to omit the acid altogether, and use instead:

Sodium fluoride	30 g	230 gr.
or Potassium fluoride	44 g	337 gr.

Add just before use:

Nitric acid	75 ccm	576 min.
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If the gelatine skin is to be kept as a film, it should first be coated rather thickly with enamel collodion, made as follows:

Pyroxyline	30 g	230 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Castor oil	20 ccm	154 min.

Allow to dry thoroughly before applying the stripping fluid.

In order to obviate the use of the fluorides, the following may also be used with success:

Potassium carbonate	100 g	770 gr.
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Formaldehyde	100 ccm	770 min.
Glycerine	100 ccm	770 min.
Denatured alcohol (meth. spirit)	300 ccm	4¾ oz.
Water to	1000 ccm	16 oz.

The carbonate should be dissolved in the glycerine, and the water and other ingredients added. This solution is rather slower than the hydrofluoric acid; it can be used in a dish and allowed to act for 20 to 30 minutes. When the film proves to be loosened, pour off the solution, replace with a mixture of 4 parts of alcohol and 6 parts water, and leave for 5 to 10 minutes; then lift the plate out, drain, and strip the film as outlined above.

Silver Printing Processes

COLLODIO-CHLORIDE PRINTING-OUT EMULSION.—The various formulas have been calculated for a total bulk of 1000 ccm (16 oz.). The correct method of making the emulsion is to prepare the collodion by dissolving the pyroxyline in the alcohol and ether, by first pouring the former on to the pyroxyline and shaking until it is thoroughly saturated, and then adding the ether. Absolute alcohol should be used, and pure methyl alcohol may replace ordinary ethyl alcohol, but the alcohol must be free from pyridine bases, which cause discoloration of the coated paper. As little water as possible should be used to dissolve the chlorides, acid, and silver, and such solutions should be mixed with alcohol prior to addition to the collodion. It is often necessary to allow the raw collodion to stand for some time for any impurities or undissolved fibers to settle down; but the best results are obtained with the specially prepared pyroxylines, sold under the name of celloidin or pyralin. The best chlorides are those of strontium and lithium, and only the crystalline salt of strontium should be used. The lithium chloride should be weighed out and dissolved in alcohol as soon as purchased, so as to make a 10 per cent solution, as it is very hygroscopic and absorbs varying quantities of moisture. These two chlorides are the most satisfactory in practice. Taking a typical formula (Hanneke), the following is the best method of mixing:

Pyroxyline	26 g	200 gr.
Alcohol	565 ccm	9 oz.
Ether	425 ccm	6¾ oz.

Add 500 ccm (8 oz.) alcohol to the pyroxylin, and shake well; then add the ether.

Lithium chloride, cryst.	3 g	23 gr.
Citric acid	5 g	38.5 gr.
Water	5 ccm	38 min.

Dissolve by the aid of heat, and add:

Alcohol	30 ccm	230 min.
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Then add to the collodion gradually with continual shaking, so as not to precipitate any of the pyroxyline:

Silver nitrate	24 g	184 gr.
Water	30 ccm	230 min.
Glycerine	7 ccm	54 min.

Heat gently until the silver dissolves, and add:

Alcohol	35 ccm	270 min.
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If any silver is thrown out in crystals, gently heat until dissolved, and add gradually while hot in small quantities to the salted collodion, shaking well after each addition. Allow to stand to ripen, and then coat. The longer the emulsion stands, the faster the printing and the softer the gradation of the prints. The following formulas are those of the leading experimenters and should be compounded on the above lines.

Niederstadt.—

Pyroxyline	28 g	215 gr.
Alcohol	630 ccm	10 oz.
Ether	350 ccm	5¾ oz.
Citric acid	2.15 g	16.5 gr.
Lithium chloride, cryst.	2.15 g	16.5 gr.
Glycerine	7 ccm	54 min.
Silver nitrate	20 g	154 gr.
Water	10 ccm	77 min.

Geldmacher.—

Pyroxyline	25 g	192 gr.
Alcohol	590 ccm	9¼ oz.

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Ether	400 ccm	6½ oz.
Citric acid	5 g	38.5 gr.
Strontium chloride, cryst.	5 g	38.5 gr.
Silver nitrate	20 g	154 gr.
Castor oil	4 ccm	31 min.
Water	20 ccm	154 min.

When castor oil is advised, which is used to keep the paper supple and prevent it from cracking, it should be mixed with an equal volume of alcohol before adding to the emulsion, and should be added last.

Wall.—

Pyroxyline	20 g	154 gr.
Alcohol	535 ccm	8½ oz.
Ether	400 ccm	6½ oz.
Citric acid	2.5 g	19 gr.
Lithium citrate	2.5 g	19 gr.
Lithium chloride, cryst.	2.5 g	19 gr.
Strontium chloride, cryst.	2.5 g	19 gr.
Silver nitrate	20 g	154 gr.
Water	20 ccm	154 min.
Glycerine	1 ccm	8 min.

Monckhoven.—

Pyroxyline	15 g	115 gr.
Alcohol	662 ccm	10 oz., 388 min.
Ether	500 ccm	8 oz.
Citric acid	1.1 g	8½ gr.
Magnesium chloride, cryst.	3.1 g	24 gr.
Silver nitrate	10 g	77 gr.
Water	10 ccm	77 min.
Ammonia	0.6 ccm	5 min.

Add the ammonia to the solution of citric acid. This was specially recommended for transparencies.

Valenta.—

Pyroxyline	20 g	154 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	1.7 g	13 gr.
Lithium chloride, cryst.	1.7 g	13 gr.
Strontium chloride, cryst.	3.4 g	26 gr.
Silver nitrate	7.5 g	58 gr.
Water	20 ccm	154 min.
Glycerine	2 ccm	16 min.

Belitzski.—

Pyroxyline	22 g	169 gr.
Alcohol	600 ccm	9 oz., 388 min.
Ether	400 ccm	6½ oz.
Citric acid	22 g	169 gr.
Lithium chloride, dry	1.25 g	9¼ gr.
Strontium chloride, cryst.	3.75 g	29 gr.
Silver nitrate	22.3 g	171 gr.
Water	15 ccm	115 min.
Glycerine	20 ccm	154 min.

Vollenbruch.—

Pyroxyline	24 g	184 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	8 g	62 gr.
Lithium chloride, cryst.	2 g	15.5 gr.
Strontium chloride, cryst.	4 g	31 gr.
Silver nitrate	28 g	214.5 gr.
Water	34 ccm	260 min.
Glycerine	13 ccm	100 min.

Anon.—

Pyroxyline	8.33 g	65 gr.
Alcohol	500 ccm	8 oz.

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Ether	500 ccm	8 oz.
Citric acid	2.1 g	16 gr.
Calcium chloride, cryst.	10.5 g	81 gr.
Silver nitrate	35 g	269 gr.

Specially recommended for transparencies.

Moss.—

Pyroxyline	17.6 g	135 gr.
Alcohol	565 ccm	9 oz.
Ether	424 ccm	7 oz.
Citric acid	1.3 g	10 gr.
Zinc chloride	3.6 g	27¾ gr.
Silver nitrate	17.6 g	135 gr.
Water	10 ccm	77 min.
Glycerine	2 ccm	15 min.

Bolton.—

Pyroxyline	23 g	177 gr.
Alcohol	490 ccm	7 oz., 400 min.
Ether	490 ccm	7 oz., 400 min.
Citric acid	4 g	31 gr.
Lithium chloride, cryst.	8 g	62 gr.
Silver nitrate	18 g	138 gr.

Hanneke.—

Pyroxyline	24.8 g	191 gr.
Alcohol	540 ccm	8½ oz.
Ether	460 ccm	7½ oz.
Citric acid	5 g	38 gr.
Calcium chloride, cryst.	4 g	31 gr.
Silver nitrate	25 g	192 gr.
Water	34 ccm	260 min.
Glycerine	5 ccm	38 min.
Castor oil	5 ccm	38 min.

Hanneke.—

Pyroxyline	26 g	200 gr.
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Alcohol	500 ccm	8 oz.
Ether	435 ccm	7 oz.
Citric acid	5 g	38 gr.
Lithium chloride, cryst.	3 g	23 gr.
Silver nitrate	24 g	185 gr.
Water	35 ccm	270 min.
Glycerine	6.6 ccm	50 min.
Castor oil	6.6 ccm	50 min.

Hanneke.—

Pyroxyline	30 g	230 gr.
Alcohol	500 ccm	8 oz.
Ether	455 ccm	7¼ oz.
Citric acid	5 g	38 gr.
Lithium chloride, cryst.	2 g	15½ gr.
Strontium chloride, cryst.	2.5 g	19 gr.
Silver nitrate	24 g	184 gr.
Water	36 ccm	274 min.
Glycerine	6 ccm	46 min.
Castor oil	6 ccm	46 min.

Hanneke.—

Pyroxyline	24 g	185 gr.
Alcohol	500 ccm	8 oz.
Ether	440 ccm	7 oz.
Citric acid	5 g	38 gr.
Calcium chloride, cryst.	4 g	31 gr.
Silver nitrate	25 g	192 gr.
Water	37 ccm	236 min.
Glycerine	4 ccm	31 min.
Castor oil	4 ccm	31 min.

This is intended for matt surface paper.

Hanneke.—

Pyroxyline	32 g	245 gr.
Alcohol	425 ccm	6¾ oz.

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Ether	575 ccm	9¼ oz.
Citric acid	6.25 g	48 gr.
Calcium chloride, cryst.	6.25 g	48 gr.
Silver nitrate	30 g	230 gr.
Water	20 ccm	154 min.

Specially suitable for transparencies.

Cobenzl.—

Pyroxyline	40 g	307 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	4.75 g	36 gr.
Lithium chloride, cryst.	4 g	31 gr.
Ammonia	5.5 ccm	42 min.
Silver nitrate	27 g	207 gr.
Glycerine	10 ccm	77 min.

Cobenzl.—

Pyroxyline	40 g	307 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	6.62 g	50 gr.
Lithium chloride, cryst.	1.25 g	9½ gr.
Ammonia	7.5 ccm	58 min.
Silver nitrate	20 g	154 gr.
Water	10 ccm	77 min.

This is intended for matt surface paper.

Sutton.—

Pyroxyline	40 g	307 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	13.3 g	102 gr.
Lithium chloride, dry	4.3 g	33 gr.
Silver nitrate	33.3 g	255 gr.

Water	5 ccm	38 min.
Castor oil	1 ccm	8 min.

Krippendorff.—

Pyroxyline	21 g	161 gr.
Alcohol	600 ccm	9½ oz.
Ether	400 ccm	6½ oz.
Citric acid	2.5 g	19 gr.
Calcium chloride, cryst.	2.5 g	19 gr.
Silver nitrate	21 g	161 gr.

Valenta.—

Pyroxyline	22.5 g	165 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	18 g	138 gr.
Calcium chloride, dry	1.4 g	10 gr.

Dissolve the above, and add:

Silver nitrate	3 g	23 gr.
Ammonia	q. s.	q. s.

Powder the silver, add just enough ammonia to form a clear solution, and add alcohol 30 ccm (230 min). Then add:

Silver nitrate	15 g	115 gr.
Water	5 ccm	38 min.
Glycerine	2.5 ccm	19 min.
Alcohol	70 ccm	538 min.

Dissolve by heat. This is specially suitable for platinum toning, and gives sepia prints without toning.

Liesegang.—

Pyroxyline	24 g	184 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Lithium chloride, cryst.	3 g	23 gr.
Silver nitrate	24 g	184 gr.

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Ashman.—

Pyroxyline	19 g	146 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	2.8 g	22½ gr.
Strontium chloride, cryst.	3.7 g	28½ gr.
Silver nitrate	19 g	146 gr.

Cronenberg.—

Pyroxyline	25 g	192 gr.
Alcohol	600 ccm	9½ oz.
Ether	400 ccm	6½ oz.
Citric acid	4 g	31 gr.
Lithium chloride, cryst.	2 g	15 gr.
Strontium chloride, cryst.	3 g	23 gr.
Silver nitrate	20 g	154 gr.
Water	15 ccm	115 min.

Lainer.—

Pyroxyline	20 g	154 gr.
Alcohol	600 ccm	9½ oz.
Ether	400 ccm	6½ oz.
Citric acid	5 g	38 gr.
Lithium chloride, cryst.	2.5 g	19 gr.
Strontium chloride, cryst.	2.5 g	19 gr.
Silver nitrate	20 g	154 gr.
Water	20 ccm	154 min.
Castor oil	4 ccm	31 min.

Van Norath.—

Pyroxyline	14.5 g	111 gr.
Alcohol	625 ccm	10 oz.
Ether	325 ccm	6 oz.
Citric acid	7.2 g	55 gr.
Ammonium chloride	10 g	77 gr.
Silver nitrate	19 g	146 gr.

Water	16 ccm	123 min.
Glycerine	8 ccm	62 min.
<i>Eder.</i> —		
Pyroxyline	21 g	152 gr.
Alcohol	600 ccm	9½ oz.
Ether	400 ccm	6½ oz.
Citric acid	5 g	38 gr.
Lithium chloride, cryst.	1.5 g	11.5 gr.
Strontium chloride, cryst.	3 g	23 gr.
Silver nitrate	14 g	107½ gr.
Water	10 ccm	77 min.
Glycerine	4 ccm	31 min.
<i>Valenta.</i> —		
Pyroxyline	22.5 g	173 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.
Citric acid	18 g	138 gr.
Calcium chloride, cryst.	1.4 g	10.7 gr.
Silver nitrate	18 g	138 gr.
Water	10 ccm	77 min.
Glycerine	2.5 ccm	19 min.

FLATTENING.—Collodion papers when toned may need to be flattened by immersing them one by one face down in a smooth-bottomed tray containing a very little water. As soon as all are in, drain off the water and let the tray stand in a slanting position for ten minutes before toning. If this is not done, the prints may curl up badly. Subsequent manipulations are the same as for P. O. P.

SILVER PHOSPHATE PAPER.—These are very rapid-printing papers with long scale of gradation. The phosphate emulsions can be used alone or mixed with citro-chloride emulsions to increase the speed:

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Collodion, 4%	2100 ccm	33½ oz.
Ether	360 ccm	5¾ oz.

Add:

Phosphoric acid, sp. gr. 1.725	10 ccm	77 min.
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Then add:

Citric acid	80 g	614 min.
Alcohol	140 ccm	2¼ oz.

Shake well, and add:

Silver nitrate	100 g	770 gr.
Hot water	115 ccm	883 min.
Alcohol	200 ccm	3¼ oz.

Shake thoroughly, and add:

Lithium carbonate	14.5 g	111 gr.
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Till there is no longer any effervescence, and add:

Glycerine	15 ccm	115 gr.
Alcohol	15 ccm	115 gr.
Calcium chromate, 10% sol.	0.5 ccm	3.8 gr.

This paper may be toned in the ordinary way or, if treated with 2.5 per cent solution of citric acid, till the yellow colour disappears and then washed, it gives rich brown tones on fixation in a hypo plus sulphite bath. Or the following may be used:

Collodion, 3½%	1960 ccm	31¼ oz.
Phosphoric acid	9 ccm	69 min.
Citric acid	77 g	591 gr.
Alcohol	130 ccm	998 min.

Shake well, and add:

Silver nitrate	100 g	770 gr.
Ammonia	q. s.	q. s.

Coarsely powder the silver, add very cautiously enough ammonia to form a clear solution, and add:

Alcohol	320 ccm	5 oz.
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Add this in small quantities to the collodion, shaking thoroughly after each addition, and add:

Ether	320 ccm	5 oz.
Glycerine	13 ccm	100 min.
Alcohol	13 ccm	100 min.

The addition of calcium chromate is not necessary with this emulsion, as it gives sufficiently brilliant prints without. This paper is specially suitable for very brief exposures and development with a metol-citric acid developer.

SILVER BROMIDE PRINTING-OUT PAPER.—This gives a very rapid-printing paper with long scale of gradation:

Citric acid	100 g	768 gr.
Alcohol	400 ccm	6½ oz.

Dissolve, and add:

Collodion, 3%	5000 ccm	80 oz.
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Then add:

Strontium bromide, anhydrous	16 g	123 gr.
Glycerine	20 ccm	154 min.
Alcohol	30 ccm	230 min.

After mixing, add:

Silver nitrate	100 g	768 gr.
Hot water	q. s.	q. s.
Alcohol	400 ccm	6½ oz.

Dissolve the silver in as little water as possible, then add the alcohol, and add to the bromised collodion in small quantities, shaking well after each addition. Finally, add:

Ether	800 ccm	13 oz.
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Allow the emulsion to stand a few minutes, and filter through glass wool. This emulsion must be mixed by orange light. It is about three times faster than commercial chloride papers and tones well in the usual baths, but is only suitable for contrasty negatives. The addition of calcium chromate gives more contrast. Even better results are obtained by replacing

some of the strontium bromide with anhydrous calcium chloride, thus using in the above:

Strontium bromide, anhydrous	10.6 g	81.3 gr.
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Calcium chloride, anhydrous	3.3 g	25.4 gr.
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If a still harder working paper is required, replace the calcium salt by uranyl chloride, 10 g (768 gr.). All these papers tone well in the usual baths, and lose but little in the fixing bath.

Manipulation.—The phosphate and bromide papers are used in the same way as ordinary printing-out papers. But, in consequence of their high sensitiveness, they should be manipulated in a yellow light, and extreme care should be taken when examining the prints during printing, otherwise a tint will be obtained over that portion of the paper examined. They both tone well either in the separate or combined baths, but are specially suitable for sepia tones by platinum toning.

Printing-Out Papers

GELATINO-CHLORIDE OR PRINTING-OUT PAPER.— This paper, also called P. O. P. in England, is coated with an emulsion of silver chloride with an organic salt of silver and excess of silver nitrate in gelatine. The greater the ratio of organic salt, the more vigorous the prints. Many formulas have been suggested, some of which either give poor results or the paper has poor keeping properties, and they are, therefore, omitted. The following will be found reliable.

Abney.—

A. Sodium chloride	13.5 g	104 gr.
Citric acid	8.5 g	65 gr.
Potassium citrate	15.5 g	119 gr.
Water	500 ccm	8 oz.
Gelatine	54 g	415 gr.
B. Silver nitrate	51 g	392 gr.
Water	400 ccm	6½ oz.
C. Chrome alum	0.6 g	4.5 gr.
Water	100 ccm	1½ oz.

Soak the gelatine in the water for 30 minutes, melt at 50° C. (122° F.), and add B at the same temperature, stirring slowly; finally, add C. This gives a slow printing paper with very long scale of gradation and is most suitable for the combined bath.

Barker.—

A. Ammonium chloride	2.9 g	22.3 gr.
Rochelle salts	5.9 g	45.25 gr.
Citric acid	8.1 g	62 gr.
Alum	15 g	115 gr.
Gelatine	136 g	1044 gr.

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Water	500 ccm	8 oz.
B. Silver nitrate	32 g	245 gr.
Water	500 ccm	8 oz.

The gelatine should be equal parts of soft and hard. Mix as above. Vigorous printing, suitable for sulphocyanide and combined baths.

Wade.—

A. Ammonium chloride	2.4 g	18.5 gr.
Rochelle salts	2.4 g	18.5 gr.
Citric acid	15.6 g	119.8 gr.
Alum	5.2 g	40 gr.
Gelatine	32 g	245 gr.
Water	500 ccm	8 oz.
B. Silver nitrate	96 g	737 gr.
Water	500 ccm	8 oz.

Mix as above. Vigorous but rather slow printing, suitable for both baths.

Beadle.—

A. Ammonium chloride	3.5 g	26.9 gr.
Rochelle salts	5 g	38 gr.
Citric acid	20 g	154 gr.
Alum	5 g	38 gr.
Water	500 ccm	8 oz.
B. Silver nitrate	37.5	288 gr.
Water	500 ccm	8 oz.

Mix as above. Vigorous and fast printing, suitable for both baths.

Ashman.—

A. Ammonium chloride	4.2 g	32.3 gr.
Tartaric acid	4 g	30.7 gr.
Sodium carbonate, cryst.	q. s.	q. s.
Citric acid	5 g	38 gr.
Ammonium citrate	15 g	115 gr.

Gelatine	127 g	975 gr.
Water	500 ccm	8 oz.
B. Silver nitrate	30.6 g	235 gr.
Water	500 ccm	8 oz.

Dissolve the tartaric acid in a little water, and neutralise with sodium carbonate; then mix as above. Very fast and vigorous printing, and suitable for both baths.

Valenta.—

A. Amonium chloride	2.8 g	21.5 gr.
Gelatine	96 g	737 gr.
Water	750 ccm	12 oz.
B. Tartaric acid	2.8 g	21.5 gr.
Sodium bicarbonate	1.4 g	10.75 gr.
Alum	1.8 g	13.8 gr.
Water	125 ccm	2 oz.
C. Silver nitrate	32 g	245 gr.
Water	125 ccm	2 oz.
Citric acid	8 g	61 gr.

Dissolve the tartaric acid and the alum in the water, and add the soda. Heat A and B to 50° C. (122° F.), and add C, heated to the same temperature, slowly with constant stirring. Vigorous, rapid printing, suitable for both baths.

All the above emulsions can be made much faster printing by allowing them to stand about 1 hour at the mixing temperature before coating. These emulsions give glossy surfaces, when coated on glossy baryta paper. If matt surface papers are required, the quantity of gelatine should be reduced by about one-sixth, and a matt surface paper used for the raw stock. A very good matt surface can be obtained by the addition of an ammoniacal solution of pale yellow resin, made as follows:

Ammonia	20 ccm	153 min.
Water	80 ccm	615 min.

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Add:

Yellow resin	4 g	31 gr.
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Then heat the mixture until the resin is dissolved, adding more ammonia if necessary. Allow to cool, and add:

Gelatine	4 g	31 gr.
Water	40 ccm	307 min.

Neutralise with hydrochloric acid, and add saturated solution of citric acid until the mixture has a distinct acid reaction. This should be added to the emulsion, allowance being made for its bulk by reducing the quantity of water used in making up the emulsion.

To obtain hard, contrasty printing papers, add to any of the above emulsions from 0.7 to 3.5 per cent of the following solution:

Chromic acid	25 g	192 gr.
Water	100 ccm	770 min.

When dissolved, add:

Calcium carbonate, pure	q. s.
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with constant stirring until the mixture remains turbid, then filter, and wash the filter with:

Water to make	250 ccm	4 oz.
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This forms approximately a 10 per cent solution of calcium chromate. The more of this is added to the emulsion, the harder it works.

PRINTING should be carried on until the high lights show a decided tinge; then the prints should be immersed in:

Salt	100 g	1½ oz.
Sodium carbonate, dry	50 g	¾ oz.
Water	1000 ccm	16 oz.

Bathe for 5 minutes, rinse for 5 minutes, and tone.

TONING may be effected either with an alkaline, a sulphonyanide, or a combined bath. The first-named does not give

such satisfactory results as the others. The following are typical formulas:

Chloride of gold	1 g	7.7 gr.
Sodium acetate, or borax or Sodium tungstate or phosphate	30 g	230 gr.
	10 g	77 gr.
Boiling water	1000 ccm	16 oz.

Or:

Borax	20 g	154 gr.
Sodium acetate	20 g	154 gr.
Boiling water	1000 ccm	16 oz.

Or:

Chloride of gold	0.25 g	1.92 gr.
Chalk	7.5 g	57.5 gr.
Chloride of lime	0.75 g	5.75 gr.
Water	1000 ccm	16 oz.

For this bath the printing must be carried much further than usual, and the prints should be merely washed in water for 5 minutes prior to toning. Or:

Chloride of gold	2 g	15 gr.
Sodium bicarbonate	30 g	230 gr.
Water	1000 ccm	16 oz.

This bath is very rapid in its action and gives blueish to violet-black tones, according to the depth of printing. Another bath that gives very rich tones is:

Chloride of gold	0.5 g	3.8 gr.
Sodium formate	60 g	460 gr.
Sodium carbonate	0.8 g	6 gr.
Water	1000 ccm	16 oz.

The sulphocyanide bath gives better tones, as a rule, than the above. A normal formula is:

Chloride of gold	0.25 g	2 gr.
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Ammonium or potassium

sulphocyanide	3.9 g	30 gr.
Boiling water	1000 ccm	16 oz.

Dissolve the gold in half the water, add to the sulphocyanide dissolved in the remainder, and use when cold. A very convenient stock solution can be made as follows:

Potassium sulphocyanide	24 g	184 gr.
Water	400 ccm	6½ oz.

Heat to 98° C. (208° F.), and add slowly with constant stirring:

Chloride of gold	8 g	61 gr.
Strontium chloride	80 g	614 gr.
Water	400 ccm	6½ oz.

This should be heated to the same temperature. Allow to cool, filter, and wash the filter with:

Water	200 ccm	2 oz.
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For use mix 1 part with 19 parts of water. The stock solution must be kept in the dark. Sulphocyanide baths are rather apt to give double-toning, that is, blueish high lights with brown shadows. The following bath is free from this defect:

Chloride of gold	1 g	7.7 gr.
Salt	20 g	154 gr.
Sodium sulphite, dry	0.5 g	3.84 gr.
Water	1000 ccm	16 oz.

This should be allowed to stand for an hour before use.

Red tones can also be obtained by the use of the following:

Ammonium sulphocyanide	5 g	38.5 gr.
Potassium iodide	0.10 to 0.15 g	0.8 to 1.15 gr.
Gold chloride	0.25 g	1.92 gr.
Water	1000 ccm	16 oz.

Combined toning and fixing baths have found much favour, as the final tone is easily determined, which is not the case

with the separate toning and fixing baths. An excellent formula and method of mixing was given by Valenta :

Hypo	200 g	3¼ oz.
Ammonium sulphocyanide	25 g	192 gr.
Lead nitrate	10 g	77 gr.
Alum	20 g	154 gr.
Water	500 ccm	8 oz.

Dissolve the hypo in about three-fourths of the water, and add the sulphocyanide; then add the alum and lead nitrate dissolved in the remainder of the water. Heat the mixture to 50° C. (122° F.) for 10 minutes, allow to cool, and filter.

For use, mix :

Stock solution	500 ccm	8 oz.
Water	500 ccm	8 oz.
Gold chloride	0.8 g	6.1 gr.

The prints must be well washed prior to toning.

FIXING.—The normal fixing bath, after any separate toning bath, should be a 10 per cent solution of hypo, or an alkaline bath may be used, such as :

Hypo	100 g	1½ oz.
Sodium carbonate, dry	6.25 g	48 gr.
Salt	12.5 g	96 gr.
Water	1000 ccm	16 oz.

Or :

Hypo	100 g	1½ oz.
Sodium sulphite, dry	12.5 g	96 gr.
Salt	12.5 g	96 gr.
Water	1000 ccm	16 oz.

Keep the prints moving in the fixing bath for 10 minutes, and then wash. Occasionally, a second fixing bath is used as conducing to greater permanency.

The tone of the prints is to a great extent dependent on the quantity of gold per area, although this, naturally, varies

with the character of the print, that is to say, the area of the dark parts of the image. The following will give a rough idea of the quantity of gold to be used for every 645 qcm (100 sq. in.): for red, 0.00324 g (0.05 gr.); for reddish-brown, 0.005 g (0.075 gr.); for brown, 0.0065 g (0.10 gr.); for warm purple-brown, 0.01 g (0.15 gr.); for cold purple-brown, 0.0125 g (0.19 gr.); for cold purple-black, 0.025 g (0.38 gr.).

PLATINUM TONING.—The tones obtained with gold range from reds to purples and browns. Colours ranging from sepia to black, without any trace of purple or red, are obtained with platinum as the toning agent. A suitable bath is:

Potassium chloroplatinite	2 g	15.4 gr.
Dilute phosphoric acid	30 ccm	230 min.
Water	1000 ccm	16 oz.

The phosphoric acid may be replaced with dilute lactic acid, or acetic, tartaric, citric, oxalic acid in like quantity; or sulphuric acid, 10 ccm (77 min.), may be used. The above baths keep well and give pure whites. The following acts well when freshly prepared:

Platinum perchloride	0.2 g	1.54 gr.
Sodium formate	6.3 g	48 gr.
Formic acid	1.2 ccm	9.2 min.
Water	1000 ccm	16 oz.

The following is also an excellent bath (Valenta):

Potassium chloroplatinite	0.5 to 1 g	3.8 to 7.6 gr.
Metaphenylenediamine	0.5 to 1 g	3.8 to 7.6 gr.
Water	1000 ccm	16 oz.

For all platinum baths, the prints must be first immersed in a 10 per cent solution of common salt for 5 minutes, then rinsed; after toning, the prints should be immersed in:

Salt	100 g	2 oz.
Sodium carbonate, dry	50 g	1 oz.

Water 1000 ccm 20 oz.
 Bathe for 5 minutes, and then fix in 10 per cent solution of hypo.

Namias.—

Platinum perchloride	1.1 g	8.5 gr.
Stannous chloride	1 g	7.7 gr.
Water	50 ccm	1 oz.

Dissolve the platinum in half the water, the tin salt in the remainder, and mix the two solutions; then add:

Hydrochloric acid	5 ccm	384 min.
Oxalic acid	10 g	77 gr.
Water to	1000 ccm	16 oz.

The prints should be washed in salt and water, and then in plain water before toning.

COMBINED PLATINUM AND GOLD TONING.—The use of gold and platinum gives pure black or blue-black tones, the blue tinge being dependent on the depth of toning with the gold. Print deeply, and immerse the print in:

Salt	25 g	192 gr.
Sodium carbonate, dry	2.5 g	19 gr.
Water	1000 ccm	16 oz.

Leave for 5 minutes, wash well, and tone in:

Borax	10 g	77 gr.
Sodium acetate, fused	10 g	77 gr.
Gold chloride	0.5 g	3.8 gr.
Water	1000 ccm	16 oz.

Then wash, and tone in:

Potassium chloroplatinite	0.7 g	5.4 gr.
Citric acid	10 g	77 gr.
Salt	16 g	123 gr.
Water	1000 ccm	16 oz.

Tone until the prints look purple-black; then wash, and fix.

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Another process with a mercury salt, which is open to question as to permanency, is to tone with:

Potassium chloroplatinite	3 g	23 gr.
Salt	20 g	154 gr.
Water	1000 ccm	16 oz.

Tone until a blue-violet colour is obtained; then rinse well, and tone again in:

Mercury sulphocyanide	20 g	154 gr.
Citric acid	20 g	154 gr.
Gold chloride	3 g	23 gr.
Water	1000 ccm	16 oz.

Wash well, and fix as usual.

GOLD AND URANIUM.—This also gives blackish prints:

Gold chloride	0.25 g	1.9 gr.
Uranium nitrate	0.25 g	1.9 gr.
Salt	4 g	31 gr.
Sodium acetate	4 g	31 gr.
Water	1000 ccm	16 oz.

Dissolve the gold and uranium, and add sufficient sodium carbonate to neutralise the solution; then add the other ingredients. Printing must be rather deep; a salt bath should be used prior to toning, and an alkaline bath for fixing.

URANIUM TONING.—This gives more or less red tones, the so-called red chalk or Bartolozzi colours. Print rather deeply, immerse in a salt bath, wash well, and tone in:

Uranium nitrate	2 g	15.4 gr.
Thiosinamine	10 g	77 gr.
Water	1000 ccm	16 oz.

Wash thoroughly, and fix.

PALLADIUM TONING.—This gives sepias and warm blacks but is not generally used.

Potassium chloropalladite	0.5 g	3.8 gr.
Salt	5 g	38.5 gr.

Sodium acetate	5 g	38.5 gr.
Water	1000 ccm	16 oz.

Printing must be deep; the salt bath prior to toning, and the alkaline fixing bath must be used.

DEVELOPING PRINTING-OUT PAPER.—If a printing-out paper be exposed for a very short time, so that only a very faint image is visible, it is possible to develop it to full intensity. The first processes were practically physical intensification methods, based on the precipitation of the free silver nitrate in the emulsion on the image. As a rule, unpleasant greenish tones were obtained. A typical formula is:

Gallic acid	5 g	38.4 gr.
Sodium acetate	10 g	77 gr.
Glacial acetic acid	10 ccm	77 min.
Water	1000 ccm	16 oz.

This should be diluted with from 5 to 10 parts of water before use. A more satisfactory result is obtained with the following:

A. Hydrochinon	10 g	77 gr.
Alcohol	100 ccm	770 min.
B. Sodium sulphite, dry	10 g	77 gr.
Citric acid	1 g	7.7 gr.
Water	100 ccm	770 min.

For use mix 5 parts each of A and B, and add 100 parts water. This works slowly, about 15 minutes being required for full development. The prints should be immersed in a 5 per cent solution of salt after development, well washed, and then toned. Pyrocatechin gives more violet tones than the above; pyrogallol works much more quickly:

Sodium sulphite, dry	50 g	384 gr.
Citric acid	10 g	77 gr.
Pyrogallol	10 g	77 gr.
Water	1000 ccm	16 oz.

Paramidophenol may also be used (Hanneke) :

Paramidophenol hydrochloride	7 g	54 gr.
Citric acid	8 g	61 gr.
Sodium sulphite, dry	25 g	192 gr.
Water	1000 ccm	16 oz.

Liesegang's aristogen for the same purpose was said to be :

Hydrochinon	10 g	77 gr.
Sodium acetate	10 g	77 gr.
Citric acid	10 g	77 gr.
Sodium sulphite, sat. sol.	500 ccm	8 oz.
Water	500 ccm	8 oz.

It was discovered by Wilson that an alkaline developer could be used, if the print were first immersed in potassium bromide solution, so as to convert the whole of the silver salts into bromide. After exposure the print should be immersed, without washing, in a 10 per cent solution of potassium bromide for 5 to 10 minutes, then well washed, and treated with the following :

A. Hydrochinon	18.2 g	140 gr.
Sodium sulphite, dry	4.5 g	35 gr.
Sulphurous acid	9 ccm	70 min.
Potassium bromide	4.5 g	35 gr.
Water	1000 ccm	16 oz.
B. Caustic soda	9 g	70 gr.
Sodium sulphite, dry	9 g	70 gr.
Water	1000 ccm	16 oz.
C. Ammonium carbonate	36.5 g	280 gr.
Ammonium bromide	36.5 g	280 gr.
Water	1000 ccm	16 oz.

Mix in equal parts before use. The following is simpler :

A. Hydrochinon	22.8 g	175 gr.
Sodium sulphite, dry	11.4 g	87.5 gr.
Sulphurous acid	11.4 g	87.5 gr.

Water	1000 ccm	16 oz.
B. Potassium bromide	62.5 g	1 oz.
Ammonia	9 ccm	70 min.
or Sodium carbonate, cryst.	45.5 g	350 gr.
Water	1000 ccm	16 oz.

For use mix 1 part of each with 1 part water. Or the following may be used:

A. Hydrochinon	3.65 g	28 gr.
Sodium sulphite, dry	3.65 g	28 gr.
Water	1000 ccm	16 oz.

For use, mix 4 parts A, 4 parts B, given above, and 8 parts water. Greater contrasts can be obtained by decreasing A to 3 parts, while flatter prints can be secured by increasing A to 7 parts, the water in each case being increased or reduced, so as to make the total bulk of the solution the same. Another formula (Kodak) is the following:

A. Hydrochinon	7.3 g	56 gr.
Sodium sulphite, dry	3.65 g	28 gr.
Potassium bromide	14.6 g	112 gr.
Ammonium bromide	29.2 g	224 gr.
Water	1000 ccm	16 oz.
B. Caustic soda	62.5 g	1 oz.
Water	1000 ccm	16 oz.
C. Tannin	16.6 g	128 gr.
Water	1000 ccm	16 oz.

For use mix 150 parts A, 30 parts B, 4 parts C.

Whichever developer be used, it is important to observe the greatest care not to expose the paper to white light, as the slightest light action is developed. It is, therefore, advisable to manipulate the paper by yellow light entirely. The image should only be faintly visible after exposure. After the bromide bath, the prints should be washed at least 3 minutes. The developed image is a pale yellow or orange colour; care

must be taken not to develop too far, and development should be stopped when the details in the high lights just begin to show. A stop bath of 10 per cent of potassium bromide or 1 per cent glacial acetic acid should be used, the prints thoroughly washed, and then toned in the usual way.

DISCO (DEFENDER) PRINTING-OUT PAPER.—Print two or three shades darker than is desired in the final print. Wash in five or six changes of water before toning, and tone in the following, keeping the prints moving:

Gold chloride solution	25 ccm	1 oz.
Water	1000 ccm	40 oz.

Add enough borax to turn red litmus paper blue. The above gold chloride solution is made by dissolving a 15-grain tube of gold chloride in 15 oz. or 425 ccm of water. When the desired tone is attained, transfer prints direct to a 4 per cent solution of hypo.

EASTMAN SOLIO PAPER.—Wash prints in 5 or 6 changes of water before toning. Tone in a plain gold bath, using .044 g (1 gr.) to 1000 ccm (48 oz.) water. Neutralise by adding a few drops at a time of saturated solution of borax, sodium bicarbonate or sal soda. Test with red litmus paper. When toned, immerse prints in running water, or:

Common salt	8 g	1 oz.
Water	1000 ccm	128 oz.

Fix not less than 10 minutes in:

Hypo	100 g	13 oz.
Water	1000 ccm	128 oz.
Solio hardener	4 ccm	½ oz.

The Solio hardener is made as follows:

Aluminum chloride	250 ccm	3 oz.
Sodium bisulphite	208 g	2½ oz.
Water	1000 ccm	12 oz.

Or the following may be used:

Hypo	75 g	6 oz.
Alum	31.25 g	2½ oz.
Sodium sulphite, dry	2 g	80 gr.
Water	1000 ccm	70 oz.

When dissolved, add:

Borax	9.5 g	¾ oz.
Hot water	125 ccm	10 oz.

This must be made 10 hours before use.

COMBINED BATH FOR SOLIO.—

A. Hypo	90 g	8 oz.
Alum	68 g	6 oz.
Sugar	22.5 g	2 oz.
Water	900 ccm	80 oz.

Thoroughly dissolve in cold water, and add:

Borax	22.5 g	2 oz.
Water	100 ccm	8 oz.

Allow to stand over night, and decant the clear liquid.

B. Gold chloride	0.2 g	7½ gr.
Lead acetate	1.6 g	64 gr.
Water	100 ccm	8 oz.

This should be shaken up before use and not filtered. For use mix 1 part B with 8 parts A. Place prints in this without washing. Tone to the desired colour, and immerse prints for 5 minutes in a stop bath of common salt, 1 : 32; then give one change of water, and fix for 10 minutes in:

Hypo	50 g	1 oz.
Sodium sulphite, dry	3 g	30 gr.
Borax	12.5 g	¼ oz.
Water	1000 ccm	20 oz.

Wash the prints for 1 hour in running water, or in 16 changes of cold water. The temperature of the combined bath should not exceed 10° C. (50° F.).

MIMOSA AUROTYPE (SELF-TONING) PAPER.—Print much

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darker than the finished prints are required to be. Place, without washing, directly in the baths, which should be at 18° C. (65° F.), and keep constantly in motion.

For sepia tones: immerse for 10 minutes in a 10 per cent solution of hypo.

For brownish-black tones: immerse for 10 minutes in a 10 per cent solution of common salt; then transfer direct to the same strength hypo solution.

For dark brown tones: immerse in:

Hypo	100 g	2 oz.
Salt	100 g	2 oz.
Water	1000 ccm	20 oz.

Variation in tones from light to dark brown is obtained by decreasing or increasing the quantity of salt in the above bath. As soon as the desired tone is obtained, the prints should be carefully washed by repeated changes of water, or in running water for 30 minutes. The most satisfactory method of drying is to place the prints between clean blotters.

GEVAERT RONIX SELF-TONING PAPER.—This is a collodio-chloride paper. Print a little darker than the finished print is desired to be. For sepia and brown tones, wash prints for three to five minutes in 2 or 3 changes of water, immersing them face down to prevent curling. Fix for 10 to 15 minutes in:

Hypo	100 g	2 oz.
Water	1000 ccm	20 oz.

Wash for one hour, blot off surplus water, but do not dry between blotters. For dark brown and blue tones, wash as before and then immerse for 5 to 10 minutes in:

Salt	100 g	2 oz.
Water	1000 ccm	20 oz.

Rinse, fix and wash as for sepia tones. Baths should be used only once.

Salted Paper

PLAIN OR SALTED PAPERS.—In this process the original surface of the paper is practically preserved, the sensitive salts being more or less in the fibers of the paper, in contradistinction to those processes in which they are suspended in an emulsion. In all cases, however, a size should be used to prevent too deep penetration into the paper. Various sizes may be used; starches, such as arrowroot, etc., tend to give brownish tones, while gelatine tends rather to more blueish tones. The size may be applied to the paper first, but it is frequently more convenient to incorporate the salts with it:

Arrowroot	20 g	154 gr.
Water	750 ccm	12 oz.

Rub the arrowroot into a cream with a little of the water; bring the remainder of the water to the boil, add the arrowroot cream slowly with constant stirring, and continue heating until a translucent liquid is formed. Then add:

Ammonium chloride	14 g	107 gr.
Sodium carbonate, cryst.	23 g	177 gr.
Citric acid	7 g	54 gr.
Water	250 ccm	4 oz.

As effervescence takes place when mixing this latter solution, it is advisable to make it in a fairly large beaker before adding it to the arrowroot. It is as well, though not necessary, to boil this solution for 5 minutes to expel the carbonic acid. The salted arrowroot mixture should be strained through fine muslin while hot. Immerse the paper in the warm solution for 2 minutes, and hang up to dry. When nearly dry, again immerse for the same time, and hang up by the oppo-

site corners to those previously used. As an alternative to this, the paper may be pinned by two corners to a flat board, and the salting solution freely applied with a broad flat brush. The solution is allowed to dry, and the operation is then repeated. Increase of the arrowroot by 50 per cent increases brilliancy of the surface. For a gelatine size one of the following may be used:

Gelatine	2 g	15 gr.
Ammonium chloride	18 g	138 gr.
Sodium citrate	18 g	138 gr.
Water	1000 ccm	16 oz.

Or:

Gelatine	4.5 g	34 gr.
Ammonium chloride	18 g	138 gr.
Sodium citrate, dry	21.5 g	165 gr.
Salt	7 g	54 gr.
Water	1000 ccm	16 oz.

Or:

Gelatine	7 g	54 gr.
Ammonium chloride	14 g	108 gr.
Water	1000 ccm	16 oz.

The more gelatine used, the higher the gloss of the resultant prints. The more citrate used, the more rapid the paper, with less contrast. Soak the gelatine in the water, melt by heat, and add the salts.

MATT AND SEMI-MATT LAC PAPERS.—With these bleached shellac with gelatine is used as a size. Unfortunately, bleached shellac is quite insoluble in aqueous mediums, and its solubility is very variable, unless freshly bleached:

Bleached lac	83 g	637 gr.
Borax	42 g	323 gr.
Water	750 ccm	12 oz.

The lac should be broken up small, added to the borax solu-

tion, and the mixture boiled until it has dissolved, or not less than 2 hours, water being added from time to time to replace that which boils away. Then take:

Bleached lac	50 g	384 gr.
Sodium phosphate	25 g	192 gr.
Water	750 ccm	12 oz.

Boil in the same way as above, mix the solutions, and add:

Gelatine	46 g	353 gr.
Water	500 ccm	8 oz.

Allow the gelatine to soak in the water for 30 minutes, and melt by heat. Filter the mixture through fine linen. Immerse the paper for 2 minutes, and hang up to dry. When nearly dry, again immerse, and hang up by the opposite end. To salt this, float the paper on:

Ammonium chloride	23 g	177 gr.
Magnesium lactate	23 g	177 gr.
Water	1000 ccm	16 oz.

Then hang up to dry. Either the borax-lac or phosphate-lac may be used alone with half the above quantity of gelatine solution.

All plain papers are most satisfactorily sensitised by brushing the silver solution on, not floating. Either a plain silver solution may be used, such as:

Silver nitrate	62.5 g	1 oz.
Water	500 ccm	8 oz.

Or an acid one:

Silver nitrate	73 g	560 gr.
Citric acid	52 g	400 gr.
Water	500 ccm	8 oz.

Or an alkaline one:

Silver nitrate	32 g	245 gr.
Ammonia	q. s.	q. s.
Water	250 ccm	4 oz.

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Dissolve the silver, add enough strong ammonia to form a clear solution, and then add:

Silver nitrate	32 g	245 gr.
Water	250 ccm	4 oz.

If necessary add a little more ammonia to clear up any precipitate formed. Papers thus prepared will not keep more than a few hours, but they print very rapidly, and give very vigorous prints. It is better to use the plain silver solutions, and fume the paper with ammonia just before use. This can be effected by cutting the paper to size and pinning to the inside of the lid of a plate box, on the bottom of which is a sheet of blotting paper wet with a 10 per cent solution of ammonia. About 10 to 15 minutes will be sufficient. Instead of the liquid ammonia, coarsely powdered ammonium carbonate may be used, and then the paper should be fumed for 30 minutes.

Printing should be carried rather deep and the prints washed with repeated changes of water until no milkiness is seen in the water, or a 5 per cent solution of salt may be used, and the prints then washed for 10 minutes. Toning may be effected with either gold or platinum. Weak baths give the best results, such as:

Borax	7 g	54 gr.
Gold chloride	0.11 g	0.85 gr.
Hot water	1000 ccm	16 oz.

Sodium phosphate or acetate may be used instead of the borax, and the tones vary from sepia to purple, according to the duration of toning. As the prints always dry a little colder, or bluer, in tone than when wet, allowance should be made for this. A suitable platinum bath is:

Potassium chloroplatinite	0.3 g	2.3 gr.
Citric acid	8 g	61 gr.
Salt	2.5 g	19 gr.

Hot water	1000 ccm	16 oz.
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After toning, the prints should be immersed in a 1 per cent solution of common salt to stop the toning action, fixed in a 5 per cent solution of hypo, and well washed.

If resin-sized paper be used, the following will give black and sepia tones direct. For black tones:

Sodium phosphate	40 g	307 gr.
Borax	20 g	154 gr.
Sodium carbonate	10 g	77 gr.
Sodium chloride	5 g	38.5 gr.
Potassium bichromate	0.01 g	0.08 gr.
Water	1000 ccm	16 oz.

For sepia tones:

Sodium phosphate	20 g	154 gr.
Borax	40 g	307 gr.
Sodium chloride	5 g	38.5 gr.
Potassium bichromate	0.08 g	0.6 gr.
Water	1000 ccm	16 oz.

Immerse the paper for 20 to 40 seconds, and dry. Sensitise on:

Silver nitrate	50 g	384 gr.
Lead nitrate	50 g	384 gr.
Water	1000 ccm	16 oz.

Neutralise this with sodium carbonate before use.

The following method is given by Namias:

Gelatine	25 g	192 gr.
Zinc chloride, cryst.	6 g	46 gr.
Citric acid	5 g	38½ gr.
Ammonia	6 ccm	46 min.
Water	1000 ccm	16 oz.

Soak the gelatine in half the water, and dissolve with heat; dissolve the acid in the remainder of the water, add the ammonia and then the zinc, mix the two solutions and filter.

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Tartaric acid may be used instead of the citric, and darker brown tones are obtained. Immerse the paper in the warm solution and dry. Sensitise by brushing over with either of the following solutions :

Silver nitrate	120 g	922 gr.
Citric acid	50 g	384 gr.
Glycerine	50 ccm	384 min.
Water	1000 ccm	16 oz.

Or :

Silver nitrate	120 g	922 gr.
Ammonia	q. s.	q. s.
Water	500 ccm	8 oz.

Use enough ammonia to form a clear solution, and then add :

Lactic acid, pure syrupy	50 ccm	384 min.
Water to	1000 ccm	16 oz.

Greater contrasts can be obtained by adding a little 5 per cent solution of potassium bichromate. A more rapid paper is obtained with the following :

Silver nitrate	100 g	768 gr.
Uranium nitrate	50 g	384 gr.
Lactic acid	50 ccm	384 min.
Water	1000 ccm	16 oz.

The following gives sepia tones, but the stock solution will not keep :

Ammonio-citrate of iron, green	66.6 g	512 gr.
Water	333 ccm	5 oz.
Potassium bichromate	1.6 g	12.3 gr.

Dissolve, and add :

Silver nitrate	33.3 g	256 gr.
Water	667 ccm	11 oz.

After printing, this paper should be immersed in a 1 per cent solution of oxalic acid, then washed, and fixed in a 2 per cent hypo bath.

A casein paper can be made as follows :

Ammonium chloride	4 g	31 gr.
Sodium citrate, neutral	40 g	310 gr.
Water	400 ccm	6½ oz.

Dissolve, and add :

Casein	40 g	310 gr.
Ammonia	50 g	384 min.
Water	350 ccm	5½ oz.

Warm this until dissolved, then add :

Silver nitrate	70 g	538 gr.
Water to	1000 ccm	16 oz.

This paper will not keep well, but can be made more stable by immersion in 3 per cent solution of citric acid.

SENSITISING LEATHER, FABRICS, ETC. (*Cobenzl*).—

Ammonium chloride	20 g	154 gr.
Gelatine	5 g	38 gr.
Water	800 ccm	13 oz.

Soak the gelatine in the water, add the chloride, melt with heat, and add to :

Soluble starch	20 g	154 gr.
Water	200 ccm	3 oz.

The material should be immersed in this until thoroughly soaked, then hung up to dry ; if the fabric is thick and soaks up much of the liquid, more water should be added. When dry, it is silvered on :

Silver nitrate	205 g	3 oz., 134 gr.
Citric acid	103 g	791 gr.
Water	1000 ccm	16 oz.

The fabric should be laid on the bottom of a large dish, a glass rod placed on the top, the liquid poured over, and the rod rolled to and fro ; this saturates the cloth without the necessity of touching it with the fingers. Artificial light should be used, and the drying should be as rapid as possible.

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After printing, the material should be immersed in salt solution, washed and toned as usual, if desired.

Thin veneer wood can be sensitised; maple and plane give the best results; pear is less satisfactory. The wood should be immersed for at least 5 minutes in:

Soft gelatine	37.5 g	288 gr.
Water	1000 ccm	16 oz.

Soak, melt by heat, and add:

Formaldehyde	7.5 ccm	58 min.
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Dry with moderate heat, and immerse 5 minutes in:

Hard gelatine	25 g	192 gr.
Soluble starch	100 g	768 gr.
Ammonium chloride	10 g	77 gr.
Water	1000 ccm	16 oz.

Again dry, and sensitise in:

Silver nitrate	100 g	768 gr.
Citric acid	83 g	637 gr.
Water	1000 ccm	16 oz.

Dry quickly. Print deeply from contrasty negatives, wash and tone as usual.

The sensitising of leather, such as split calfskin, is an easy matter, but it will not keep after sensitising. It is advisable to coat it first with plain collodion and then with a collodio-chloride emulsion. Or the following may be used:

Hard gelatine	2.5 g	19 gr.
Soluble starch	10 g	77 gr.
Potassium bromide	8.75 g	67 gr.
Cadmium bromide	8.75 g	67 gr.
Cadmium iodide	2.5 g	19 gr.
Ammonium chloride	2.5 g	19 gr.
Water	1000 ccm	16 oz.

Saturate the material, dry quickly, and sensitise in:

Silver nitrate	40 g	307 gr.
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Citric acid	50 g	384 gr.
Water	1000 ccm	16 oz.

Clean brilliant negatives and short exposure to a bright light are required; enlargements may also be made. After exposure the material should be immersed in a 5 per cent solution of ammonium chloride, and developed with:

Pyrogallol	2.5 g	19 gr.
Hydrochinon	7.5 g	58 gr.
Citric acid	10 g	77 gr.
Sodium sulphite, dry	34 g	260 gr.
Water	1000 ccm	16 oz.

Temperature 35° C. (95° F.). As soon as the image has well appeared, fix in an acid bath, and tone with gold.

For an emulsion for fabrics, either of the following may be used:

Hard gelatine	120 g	2 oz., 47 gr.
Water	1300 ccm	23 oz.

Dissolve, and add:

Zinc bromide, cryst.	43 g	332 gr.
Cadmium iodide	1 g	7.7 gr.
Cadmium chloride	3 g	23 gr.

Next, add at 70° C. (158° F.):

Alcohol	500 ccm	8 oz.
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Then add in the darkroom:

Silver nitrate	50 g	384 gr.
Water	100 ccm	770 min.

Finally, add:

Alcohol	100 ccm	770 min.
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Digest for 2½ hours at 80° C. (176° F.), and then cool down with constant stirring until the temperature is 15° C. (59° F.), when the emulsion will sink to the bottom of the vessel; this should be collected, washed, and melted with the addition of:

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Sodium carbonate	0.2 g	1.5 gr.
Ammonium bromide	0.2 g	1.5 gr.
Water	2400 ccm	38½ oz.

Melt at 30° C. (86° F.), and saturate the fabric. This can also be used for paper, and gives from red to black tones, according to exposure and developer.

Bromide Paper

EXPOSURE.—The most convenient light-source is an electric incandescent lamp of comparatively low candle-power, not more than 16, otherwise the duration of exposure is so brief that serious errors may arise. It is preferable to have the light-source fitted with a push button, so that the light is only obtained while the button is pressed. This is handier than the usual form of switch. The light should be located as nearly as possible on a line with the center of the printing frame, and the end of the bulb should be towards the frame. The bench should be marked plainly with a scale of distances, such as a yard measure, exactly parallel to the axial line of the light, and the frame should always be placed squarely at right angles to this scale. The exposures are practically as the squares of the distances between the light and the frame; that is to say, with a given light, negative, and paper, if the exposure at 12 inches is 5 seconds, it will be as $12^2:24^2$ at 24 inches, or as 144:576, or 1:4. The thinner the negative, the greater should be the distance from the light. It is advisable not to select too short a distance, as the exposures are inconveniently short. The rule that the exposures are as the square of the distances is not strictly correct, for the light has less penetrative power at greater distances and will not pass through the denser parts of the negative. Slow papers give plucky results from flat negatives, and rapid papers give soft results from hard negatives.

DEVELOPMENT.—Practically, the developers for bromide papers may be considered as half the strength of negative developers. Almost any reducing agent may be used, though pyro is the least suitable on account of its liability to stain

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both gelatine and paper and its tendency to give rusty black tones. Amidol and metol-hydrochinon, also called M. Q., are the favourites; the former tends to give blue-black, and the latter pure black tones.

Amidol.—This developer will not keep more than three days, and the most convenient method is to make up a 5 per cent solution of dry sodium sulphite, add 0.1 per cent of potassium bromide ($\frac{1}{2}$ gr. to the ounce), add 0.8 per cent amidol (4 gr. to the ounce), and dilute with an equal bulk of water just before use:

Sodium sulphite, dry	34 g	260 gr.
Potassium bromide	1.3 g	10 gr.
Water	1000 ccm	16 oz.

When dissolved, add:

Amidol	5.2 g	40 gr.
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Metol-Hydrochinon.—The mean of the maker's formulas is:

Metol	3.5 g	27 gr.
Hydrochinon	3 g	23 gr.
Sodium sulphite, dry	21 g	160 gr.
Sodium carbonate, dry	16 g	123 gr.
Potassium bromide	1.3 g	10 gr.
Water	1000 ccm	16 oz.

Eastman Metol-hydrochinon Developer.—

Elon (metol)	5 g	$\frac{1}{2}$ oz.
Sodium sulphite, dry	75 g	$7\frac{1}{2}$ oz.
Hydrochinon	20 g	2 oz.
Sodium carbonate, dry	105 g	$10\frac{1}{2}$ oz.
Potassium bromide	2.5 g	120 gr.
Wood alcohol	130 ccm	13 oz.
Hot water	1000 ccm	100 oz.

For use mix 1 part with 6 parts water. Temperature 21° C. (70° F.).

Eastman Amidol Developer.—

Sodium sulphite, dry	120 g	1½ oz.
Acrol (amidol)	40 g	½ oz.
Water	1000 ccm	12½ oz.

For use mix:

Stock solution	157 ccm	1½ oz.
Potassium bromide, 10% sol.	1.7 ccm	8 drops
Water	843 ccm	6 oz.

Time of development should be not less than a minute and a quarter.

GEVAERT ORTHOBROM AND NOVABROM BROMIDE PAPERS.—

Developer for vigorous prints:

Metol	1 g	8 gr.
Hydrochinon	3.5 g	28 gr.
Sodium sulphite, cryst.	38 g	228 gr.
Sodium carbonate, cryst.	50 g	384 gr.
Potassium bromide	1 g	8 gr.
Water	1000 ccm	16 oz.

For soft prints:

Metol	5 g	40 gr.
Hydrochinon	1.5 g	12 gr.
Sodium sulphite, cryst.	62 g	1 oz.
Potassium carbonate	18.5 g	150 gr.
Potassium bromide	1 g	8 gr.
Water	1000 ccm	16 oz.

Dissolve in order given. Prints of any required degree of vigour may be made by mixing the two solutions in suitable proportions. Development time, 3 minutes at 18° C. (65° F.). After rinsing, fix in:

Hypo	250 g	4 oz.
Potassium metabisulphite	25 g	192 gr.
Water	1000 ccm	16 oz.

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Fix 10 minutes, wash 1 to 2 hours, and do not dry between blotters.

HAMMER OPAL PLATES.—

Metol	5 g	$\frac{1}{4}$ oz.
Hydrochinon	20 g	1 oz.
Sodium sulphite	75 g	$3\frac{3}{4}$ oz.
Sodium carbonate	125 g	$6\frac{1}{4}$ oz.
Potassium bromide	1.25 to 2.5 g	$\frac{1}{2}$ to 1 dr.
Water	1000 ccm	50 oz.

Add from 120 to 200 ccm (6 to 10 oz.) wood alcohol to prevent precipitation. For use mix 1 part of above with 6 parts water.

FACTORIAL DEVELOPMENT FOR BROMIDE PAPER.—Dr. B. J. Glover puts forward a strong case for the application of the Watkin's factorial system for bromide papers, which, however, is not applicable to development papers on account of the very short time of appearance. The developer he adopts is the Kodak amidol formula at a temperature of 17° C., and he finds a remarkable coincidence between the exposure multiplied by the time of development, in seconds, for prints showing practically the same result. This forms a constant, which is 1,800. Three cases are cited in which the exposures were 30, 15 and 10 seconds respectively and the factors 10, 15 and $22\frac{1}{2}$ used. The results were practically indistinguishable; and the total times of development were 60, 120 and 180 seconds respectively, which, as will be seen, when multiplied by the exposures, equal 1,800. He formulates his first rule as follows: development must not be for a shorter time than that required to produce the maximum black of the paper. Accepting this, it will be obvious that it will be unnecessary to calculate both exposure *and* development; one only need be determined and the other is at once deduced therefrom, which practically forms his second rule. As he puts it: a knowledge

of either the correct exposure or the correct time of development is a complete guide to both exposure and development, since they are dependent variables in the sense that the product of one with the other is a constant quantity. The third rule is: the maximum development allowable is that which just stops short of fog or stain or both. Each developer has its own factor, which in the sense of the above rules varies within certain limits, these for the Kodak amidol being from 10 to 30. As a mean 12 is convenient, and it is advisable to adopt this and make trial exposure strips. He lays down the axiom that the correct exposure for a bromide print is that which, when developed with any developer to an appropriate Watkin's factor, yields a print of the desired depth. This is the only definition in existence, which has any value in practical work.

Developing-Out Papers

DEVELOPMENT OR GASLIGHT PAPERS.—These are comparatively slow papers, which can be manipulated in not too bright a white light, though it is safer to use a yellow or bright orange safe-light.

EXPOSURE.—The exposure is much longer than with bromide paper, and it is advisable to use a high candle-power incandescent lamp, such as a 50-watt Mazda. The distance from the lamp should not be more than 12 inches. Or magnesium ribbon may be used, 1 inch at a distance of 12 inches being sufficient for an average negative for cold tones. The longer the exposure, with corresponding increase of bromide in the developer, the warmer the tones.

DEVELOPMENT.—Any developer may be used, and, practically, negative developers, with bromide, may be used full strength.

Amidol.—

Sodium sulphite, dry	32 g	½ oz.
Potassium bromide	0.13 g	1 gr.
Water	1000 ccm	16 oz.

When dissolved, add:

Amidol	5.2 g	40 gr.
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For notes as to the keeping of this, see under Bromide Paper.

Metol-Hydrochinon.—The mean of the maker's formulas is:

Metol	1.9 g	14½ gr.
Hydrochinon	6.2 g	47 gr.
Sodium sulphite, dry	28 g	215 gr.
Sodium carbonate, dry	41 g	315 gr.
Potassium bromide	0.4 g	3 gr.

Water	1000 ccm	16 oz.
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All formulas given under Bromide Paper are applicable to development papers.

NON-ABRASION DEVELOPERS.—Glossy development papers are likely to show black hair-like lines, due to abrasion of the sensitive surface. The following has been suggested as obviating these:

Metol	3.5 g	27 gr.
Hydrochinon	6 g	46 gr.
Sodium sulphite, dry	12 g	92 gr.
Sodium carbonate, dry	20 g	154 gr.
Potassium bromide	0.4 g	3 gr.
Potassium iodide	2 g	15.4 gr.
Water	1000 ccm	16 oz.

The iodide is the active agent and may be added in about the above ratio to any developer. Or add 0.156 per cent of hypo to the developer, that is, 1.56 g per liter (12 gr. per 16 oz.).

PYRO DEVELOPER FOR WARM BROWN TONES ON DEVELOPMENT PAPERS.—

A. Potassium metabisulphite	5 g	38.5 gr.
Pyrogallol	22 g	169 gr.
Potassium bromide	15 g	115 gr.
Water	1000 ccm	16 oz.
B. Sodium sulphite, dry	87.5 g	672 gr.
Sodium carbonate, dry	87.5 g	672 gr.
Water	1000 ccm	16 oz.

For use mix A 10, B 20, water 70 parts. The image appears in from 30 to 40 seconds, and development is complete in 3 or 4 minutes. The prints should be fixed in an acid bath without intermediate washing.

VITAVA (KODAK) PAPER.—

1. Elon (metol)	6.5 g	100 gr.
Sodium sulphite, dry	100 g	3¼ oz.

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Hydrochinon	23 g	¾ oz.
Sodium carbonate, dry	46 g	1½ oz.
Potassium bromide	3.25 g	50 gr.
Wood alcohol	138 ccm	4½ oz.
Water to	1000 ccm	32 oz.
2. Sodium carbonate, dry	46 g	1½ oz.
Water	1000 ccm	32 oz.

In preparing No. 1, dissolve each chemical in three-fourths of the water, heated to about 53° C. (125° F.), before the next is added. Normal development should require from 1½ to 2 minutes.

For Etching Brown, use: 125 ccm of No. 1, water to make 1000 ccm, and add 7 ccm of 10 per cent solution of potassium bromide (2 oz. of No. 1, water to 16 oz., and 60 min. of potassium bromide solution).

For Athena Old Master and Glossy, use: No. 1, 125 ccm, No. 2, 62.5 ccm, water to 1000 ccm, and add 3.5 ccm of 10 per cent solution potassium bromide (No. 1, 2 oz., No. 2, 1 oz., water to 16 oz., and add 30 min. of potassium bromide solution). Temperature 21° C. (70° F).

ARTURA.—

1. Elon (metol)	6.5 g	100 gr.
Sodium sulphite, dry	100 g	3¼ oz.
Hydrochinon	23 g	¾ oz.
Sodium carbonate, dry	78 g	2¼ oz.
Potassium bromide	3.25 g	50 gr.
Water to	1000 ccm	32 oz.

Then add:

Wood alcohol	138 ccm	4¼ oz.
2. Elon (metol)	23.5 g	¾ oz.
Sodium sulphite, dry	100 g	3¼ oz.
Potassium bromide	9.75 g	150 gr.
Water to	1000 ccm	32 oz.

Then add:

Wood alcohol	200 ccm	6½ oz.
3. Sodium carbonate, dry	94 g	3 oz.
Water	1000 ccm	32 oz.

For normal developer for Artura Iris, use: No. 1, 125 ccm, potassium bromide, 10 per cent solution, 3.5 ccm, water to 1000 ccm (No. 1, 2 oz., bromide solution, 30 min., water to 16 oz.).

For soft developer for Artura Iris, use: No. 1, 62.5 ccm, No. 2, 62.5 ccm, water to 1000 ccm (No. 1, 1 oz., No. 2, 1 oz., water to 16 oz.).

For Artura Carbon Black or Carbon Green, use: No. 1, 250 ccm, No. 3, 62.5 ccm, potassium bromide, 10 per cent solution, 3.5 ccm, water to 1000 ccm (No. 1, 4 oz., No. 3, 1 oz., bromide solution, 30 min., water to 16 oz.).

For Non-Curling Film, use: No. 1, 250 ccm, water to 1000 ccm (No. 1, 4 oz., water to 16 oz.). Temperature of all developers 21° C. (70° F.).

Roylon Developer.—

Roylon	1.5 g	24 gr.
Sodium sulphite, dry	23 g	¾ oz.
Hydrochinon	4.5 g	72 gr.
Sodium carbonate, dry	23 g	¾ oz.
Potassium bromide, 10% sol.	10.5 ccm	90 min.
Water to	1000 ccm	32 oz.

Suitable for all grades of Artura, except Carbon Black, for which there should be added 16 ccm of 10 per cent solution of potassium bromide to 1000 ccm (½ oz. to 16 oz.).

Kodelon Developer.—For amateur use for Velox, Azo (and other developing papers) and bromide papers. Dissolve in the order named:

Water	1000 ccm	64 oz.
Kodelon	0.8 g	25 gr.

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Hydrochinon	2.9 g	90 gr.
Sodium sulphite, dry	10.5 g	330 gr.
Sodium carbonate, dry	35 g	2¼ oz.

Add 2 drops of 10 per cent potassium bromide solution to each 30 ccm (1 oz.) of developer. Use full strength at 18° C. (65° F.).

For professional use; soft developer for Artura Iris, Azo and other professional papers. Dissolve in order named:

Water	1000 ccm	40 oz.
Kodelon	0.5 g	10 gr.
Hydrochinon	2 g	40 gr.
Sodium sulphite, dry	9.5 g	180 gr.
Sodium carbonate, dry	9.5 g	180 gr.

Add 1 drop of saturated solution of potassium bromide to each 60 ccm (2 oz.) of developer. Use full strength at 18° C. (65° F.).

Tozol Developer.—Stock solution for developing papers. Dissolve in the order named:

Hot water	1000 ccm	30 oz.
Tozol	33 1/3 g	1 oz.
Sodium sulphite, dry	100 g	3 oz.
Sodium carbonate, dry	75 g	2¼ oz.
Potassium bromide	3 g	45 gr.
Wood alcohol	150 g	4½ oz.

For portraiture on Artura and Azo use 100 ccm of stock solution to 700 ccm water (1 oz. to 7 oz.).

For Velox, bromide, and amateur finishing grades of Azo, add 67 ccm (2 oz.) of dry sodium carbonate to the above quantity of stock solution and for use dilute 1 to 2 for Velox and Azo, and 1 to 6 for bromide papers. Use at 21° C. (70° F.).

HALOID PAPERS.—

Metol	0.78 g	15 gr.
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Sodium sulphite, dry	12.5 g	½ oz.
Hydrochinon	3.12 g	60 gr.
Sodium carbonate, dry	12.5 g	½ oz.
Water	1000 ccm	40 oz.

Add one drop saturated potassium bromide solution to every 2 oz. of developer (1 ccm to every liter). Times of development at 18° C. (65° F.): Portraya 1½ to 2, Industro 1¼ to 1¾, Rito ¾ to 1½, Kalo 1 to 1½, Enlarging 1¼ to 1¾ minutes. The use of Kalo (slow speed) or Rito (fast speed) with the following developer gives cold, neutral or blue-black tones:

Metol	5 g	½ oz.
Sodium sulphite, dry	75 g	7½ oz.
Hydrochinon	20 g	2 oz.
Sodium carbonate, dry	125 g	12½ oz.
Potassium bromide	2 g	100 gr.
Hot water	1000 ccm	100 oz.

For use mix 1 part stock solution with 3 parts water.

HALOID KALO & RITO.—For neutral black tones:

Metol	0.78 g	15 gr.
Sodium sulphite, dry	12.5 g	½ oz.
Hydrochinon	3.12 g	60 gr.
Sodium carbonate, dry	22 g	420 gr.
Water	1000 ccm	40 oz.

Add one drop saturated solution potassium bromide to each two ounces of developer (1 ccm to every liter).

ANSCO CYKO PAPER.—

Metol	0.78 gr.	15 gr.
Sodium sulphite, dry	25 g	1 oz.
Hydrochinon	3.12 g	60 gr.
Sodium carbonate, dry	18.75 g	¾ oz.
Potassium bromide	0.26 g	5 gr.

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Water 1000 ccm 40 oz.
 Temperature 18° C. (65° F.).

ANSCO NOKO PAPER.—

Metol	0.78 gr.	15 gr.
Hydrochinon	2.8 g	60 gr.
Sodium sulphite, dry	25 g	1 oz.
Sodium carbonate, dry	18.75 g	¾ oz.
Potassium bromide	0.376 g	8 gr.
Water	1000 ccm	40 oz.

Time of development 45 to 60 seconds.

ENLARGING CYKO.—

Metol	0.78 g	15 gr.
Sodium sulphite, dry	12.5 g	½ oz.
Hydrochinon	3.12 g	60 gr.
Sodium carbonate, dry	12.5 g	½ oz.
Potassium bromide, sat. sol.	1 to 3 ccm	20 to 60 min.
Warm water	1000 ccm	40 oz.

Temperature 18° C. (65° F.).

KODAK VELVET GREEN AND VELOX PAPERS.—

Metol	0.5 g	7 gr.
Sodium sulphite, dry	7 g	110 gr.
Hydrochinon	2 g	30 gr.
Sodium carbonate, dry	13 g	150 gr.
Potassium bromide, 10%	40 drops	40 drops
Water	300 ccm	10 oz.

MIMOSA VEROTYPE PAPER.—For pure black tones, use:

Sodium sulphite, cryst.	50 g	1¾ oz.
Metol	2 g	30 gr.
Hydrochinon	6 g	92 gr.
Sodium carbonate, cryst.	135 g	4¾ oz.
Potassium bromide, 10% sol.	10 ccm	180 min.
Water	1000 ccm	35 oz.

Or the following separate solution developer:

A. Metol	14 g	216 gr.
Sodium sulphite, cryst.	140 g	5 oz.
Water	1000 ccm	35 oz.
B. Hydrochinon	17.5 g	270 gr.
Sodium sulphite, cryst.	100 g	3½ oz.
Water	1000 ccm	35 oz.
C. Sodium carbonate, cryst.	150 g	5¼ oz.
Hot water	1000 ccm	35 oz.
D. Potassium carbonate	150 g	5¼ oz.
Water	1000 ccm	35 oz.

For use mix as follows: for brown-black tones 1 part A, 1 part B, 1 part C, and 3 parts water. By reducing B, a softer developer is obtained; by reducing A, a harder developer is obtained. For blue-black tones: mix 1 part A, 1 part B, 1 part D and 3 parts water. To every 35 oz. of developer, add 1½ to 2¾ drams of 10 per cent solution of potassium bromide.

Hydrochinon-Soda.—

Sodium sulphite, cryst.	120 g	4¼ oz.
Hydrochinon	24 g	¾ oz.
Sodium carbonate, cryst.	250 g	8¾ oz.
Potassium bromide, 10% sol.	5 ccm	1½ drams
Hot water	1000 ccm	35 oz.

Time of development 1 minute.

EASTMAN AZO PAPER.—

Elon (metol)	6.25 g	60 gr.
Sodium sulphite, dry	100 g	2 oz.
Hydrochinon	25 g	½ oz.
Sodium carbonate, dry	75 g	1½ oz.
Potassium bromide	3.125 g	30 gr.
Wood alcohol	150 ccm	3 oz.
Hot water	1000 ccm	20 oz.

For use mix 2 oz. stock solution, water 14 oz., and add

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4 drops saturated solution potassium bromide. Temperature 21° C. (70° F.). Prints must be exposed so that the time of development will be not less than 45 seconds for No. 1 or 30 seconds for No. 2. For commercial and amateur printing, the following is recommended:

Elon (metol)	0.73 g	7 gr.
Sodium sulphite, dry	13 g	110 gr.
Hydrochinon	3.6 g	30 gr.
Sodium carbonate, dry	18 g	150 gr.
Potassium bromide, sat. sol.	0.5 ccm	5 drops
Hot water	1000 ccm	20 oz.

Temperature 21° C. (70° F.).

DEFENDER COMMERCIAL PAPER.—

Metol	0.77 g	15 gr.
Sodium sulphite, dry	25 g	1 oz.
Hydrochinon	3 g	60 gr.
Sodium carbonate, dry	18 g	¾ oz.
Potassium bromide, sat sol.	8 drops	10 drops
Water	1000 ccm	40 oz.

Temperature 18° C. (65° F.).

DEFENDER VELOUR BLACK.—

Metol	1.54 g	30 gr.
Sodium sulphite, dry	12.5 g	½ oz.
Hydrochinon	4 g	80 gr.
Sodium carbonate, dry	12.5 g	½ oz.
Potassium bromide, sat. sol.	512 drops	600 drops
Water	1000 ccm	40 oz.

For commercial use:

Metol	1 g	20 gr.
Sodium sulphite, dry	12.5 g	½ oz.
Hydrochinon	3 g	60 gr.
Sodium carbonate, dry	18.75 g	¾ oz.
Potassium bromide	1 g	20 gr.

Water	1000 ccm	40 oz.
DEFENDER PROFESSIONAL PAPER.—		
Metol	0.77 g	15 gr.
Sodium sulphite, dry	12.5 g	½ oz.
Hydrochinon	3 g	60 gr.
Sodium carbonate, dry	12.5 g	½ oz.
Water	1000 ccm	40 oz.
Potassium bromide,		
sat. sol.	25 to 70 drops	30 to 80 drops

The quantity of bromide determines the tone; with the smallest quantity a comparatively cold tone results with from 1 to 1½ minutes development for correctly exposed prints.

Alternative developer for black and white prints:

1. Metol	2 g	150 gr.
Sodium sulphite, dry	33.3 g	5 oz.
Hydrochinon	8.3 g	1¼ oz.
Water	1000 ccm	150 oz.
2. Sodium carbonate, dry	100 g	3 oz.
Water	1000 ccm	30 oz.

For use mix:

Solution No. 1	312.5 ccm	10 oz.
Solution No. 2	62.5 ccm	2 oz.
Water	625 ccm	20 oz.
Potassium bromide	2 g	32 gr.

Develop from 1¼ to 3 minutes. Special stress is laid on the necessity of increasing the quantity of bromide with increase of the temperature of the developer.

GEVAERT VITTEX (rapid gas-light paper).—For vigorous prints:

A. Metol	0.9 g	13 gr.
Sodium sulphite, cryst.	35 g	1 oz.
Hydrochinon	3.3 g	50 gr.
Potassium carbonate, cryst.	70 g	2 oz.

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Potassium bromide	0.5 g	8 gr.
Water	600 ccm	20 oz.

Dissolve in order indicated. Development, 40 to 60 seconds at 16° C. (60° F.).

For soft prints:

B. Metol	1.7 g	25 gr.
Sodium sulphite, cryst.	28 g	¾ oz.
Hydrochinon	0.5 g	8 gr.
Potassium carbonate, cryst.	35 g	1 oz.
Potassium bromide	0.5 g	8 gr.
Water	600 ccm	20 oz.

Time and temperature as before. Prints of any desired vigour can be obtained by mixing A and B in appropriate proportions. After development, rinse and fix in:

Hypo	250 g	5 oz.
Water	1000 ccm	20 oz.
Potassium metabisulphite	25 g	½ oz.

Fix for 10 minutes, wash one to two hours. Dry flat, but not between blotters. This paper gives warm black tones by simple development, and is not intended for sepia toning in sulphide solutions.

GEVAERT NOVA-GAS (commercial gas-light paper).—

Metol	1 g	15 gr.
Hydrochinon	4 g	60 gr.
Sodium sulphite, cryst.	35 g	1 oz.
Sodium carbonate, cryst.	70 g	2 oz.
Potassium bromide, 10% sol.	30 to 60 drops	
Water	600 ccm	20 oz.

Dissolve in order named. Develop at 18° C. (65° F.). If whites are not clean, add 15 drops 10 per cent solution of potassium bromide to each ounce (30 ccm) developer. After development, rinse thoroughly and fix in:

Hypo	150 g	3 oz.
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Potassium metabisulphite	25 g	½ oz.
Water	1000 ccm	20 oz.

Fix 10 to 15 minutes and wash 1 to 2 hours.

SHORT STOP BATH.—For all developing papers it is advisable to use a short stop bath. The prints should be rinsed as soon as sufficiently developed, and then immersed in:

Acetic acid, 28%	47 ccm	1½ oz.
Water	1000 ccm	32 oz.

Use a fresh bath for each batch of prints, as the acid will become neutralized by the alkali from the developer. To reduce glacial acetic acid (99½%) to 28%, add 800 ccm of water to 300 ccm of the glacial acetic acid (8 oz. to 3 oz.).

Toning Bromide and Gaslight Prints

COPPER TONING.—Various shades from red to violet-brown are obtainable by this process, which is based on the deposition of red cuprous ferrocyanide on the image with the simultaneous formation of white silver ferrocyanide. It is actually an intensification process; therefore, the primary image must not be developed too far.

Single solution (Ferguson) :

Cupric sulphate, 10% sol.	106 ccm	1 oz., 5 dr.
Potassium citrate, 10% sol.	800 ccm	13 oz.
Potassium ferricyanide, 10% sol.	94 ccm	1 oz., 3 dr.

This solution will keep and does not stain plates or papers; the colours are dependent on the length of immersion. Sed-laczek gives the following formulas for various tones, and, as the baths will not keep well, they should be mixed just before use. In all these formulas, the quantities of the solutions should be added to the stated amount of water in the order given :

Potassium citrate, 10% sol.	250 ccm	3¾ oz.
Cupric sulphate, 10% sol.	40 ccm	290 min.
Ammonia alum, sat. sol.	100 ccm	1½ oz.
Potassium ferricyanide, 10% sol.	30 ccm	218 min.
Water	750 ccm	12 oz.

This gives red or violet-brown tones with clear whites.

Ammonium oxalate, sat. sol.	200 ccm	3 oz.
Cupric sulphate, 10% sol.	40 ccm	290 min.
Ammonium carbonate, 10% sol.	10 ccm	72 min.

Potassium ferricyanide,		
10% sol.	30 ccm	218 min.

Water	800 ccm	12 oz.
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This gives cherry red tones with a faint tinge in the whites.

Potassium oxalate, 10% sol.	100 ccm	1½ oz.
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Cupric sulphate, 10% sol.	40 ccm	288 min.
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Tartaric acid, 10% sol.	10 ccm	72 min.
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Potassium ferricyanide,		
10% sol.	30 ccm	216 min.

Water	800 ccm	12 oz.
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This gives red-brown tones. The addition of 100 ccm (1½ oz.) saturated solution of ammonia alum gives browner tones.

Ammonium oxalate, sat. sol.	200 ccm	3 oz.
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Cupric sulphate, 10% sol.	40 ccm	288 min.
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Oxalic acid, sat. sol.	10 ccm	72 min.
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Potassium ferricyanide,		
10% sol.	30 ccm	216 min.

Water	800 ccm	12 oz.
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This gives a reddish-violet tone. The following bath gives the so-called red chalk or Bartolozzi tones, but the whites are tinged:

Ammonium carbonate,		
sat. sol.	570 ccm	8 oz.

Cupric sulphate, 10% sol.	127 ccm	856 min.
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Potassium ferricyanide,		
10% sol.	304 ccm	5 oz.

A weak ammonia bath, 1 per cent, will clear the whites. The following gives reddish-brown tones with clear whites (Crab-tree):

Cupric sulphate	12 g	92 gr.
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Potassium citrate	75 g	576 gr.
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Ammonium carbonate	6 g	46 gr.
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Potassium ferricyanide	12 g	92 gr.
Water	1000 ccm	16 oz.

With all the above baths much more transparent images may be obtained by immersion for about 5 minutes in a 5 per cent hypo solution. A violet-red tone is obtained (Somerville) by treating a copper-toned image with:

Ammonia-iron alum,		
10% sol.	100 ccm	1½ oz.
Hydrochloric acid	10 ccm	72 min.
Potassium bromide, 10% sol.	80 ccm	576 min.
Water	1000 ccm	16 oz.

Bleach the print in:

Cupric sulphate	100 g	768 gr.
Potassium bromide	100 g	768 gr.
Water	1000 ccm	16 oz.

Then immerse in a 2 per cent solution of nitric acid for 5 minutes, wash well, and immerse in a 5 per cent solution of sodium sulphite, which gives a brown tone.

Bleach the print in:

Potassium ferricyanide	13.5 g	104 gr.
Potassium bromide	3.5 g	27 gr.
Water	1000 ccm	16 oz.

Wash for 10 minutes; then immerse for 1 minute in:

Acid potassium oxalate	27 g	208 gr.
Water	1000 ccm	16 oz.

Then bathe for a few seconds in a 6 per cent solution of ammonia, and immerse in:

Cupric sulphate	10 g	77 gr.
Hydrochloric acid	1.5 ccm	12 min.
Water	1000 ccm	16 oz.

Until the desired colour is obtained; then wash and fix.

Immerse the prints in (Namias):

Rochelle salts	100 g	768 gr.
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Cupric sulphate	10 g	77 gr.
Water	1000 ccm	16 oz.
Potassium ferricyanide	5 g	38 gr.
Ammonia	q. s.	q. s.

Add enough ammonia to form a clear solution. This gives violet tones.

URANIUM TONING.—Treatment of a silver image with a mixture of a soluble uranium salt and ferricyanide of potassium results in brown to red images, the colour being dependent on the ratio of the two salts and the duration of toning. Intensification also takes place; therefore, the prints should not be too intense at first. The colour is dependent on the deposition of uranium ferrocyanide, which is soluble in alkalis. Long washing in ordinary water, therefore, will reduce the colour by dissolving the uranous salt.

The following baths were recommended by Sedlaczek; all the quantities given represent the amount of 10 per cent solution that should be used, unless otherwise stated:

Uranium nitrate	50 ccm	350 min.
Ammonium oxalate	100 ccm	700 min.
Hydrochloric acid	10 ccm	70 min.
Potassium ferricyanide	20 ccm	140 min.
Water	1000 ccm	16 oz.

This gives brown tones.

Uranium nitrate	50 ccm	350 min.
Potassium oxalate	50 ccm	350 min.
Hydrochloric acid	10 ccm	70 min.
Potassium ferricyanide	20 ccm	140 min.
Water	1000 ccm	16 oz.

This gives warm brown tones. If a saturated solution of oxalic acid be used instead of the potassium oxalate, redder tones are obtained.

Uranium nitrate	50 ccm	350 min.
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Rochelle salts	70 ccm	490 min.
Tartaric acid	100 ccm	700 min.
Potassium ferricyanide	20 ccm	140 min.
Water	1000 ccm	16 oz.

This gives rich brown tones.

Uranium nitrate	50 ccm	350 min.
Rochelle salts	50 ccm	350 min.
Ammonia alum, sat. sol.	100 ccm	700 min.
Tartaric acid	50 ccm	350 min.
Potassium ferricyanide	20 ccm	140 min.
Water	1000 ccm	16 oz.

This gives reddish-brown tones.

A simpler formula is:

A. Uranium nitrate	5 g	38 gr.
Water	500 ccm	8 oz.
B. Potassium ferricyanide	5 g	38 gr.
Glacial acetic acid	14 ccm	96 min.
Water	500 ccm	8 oz.

Mix just before use. Or the prints may be immersed in B until bleached, well washed, and then soaked in A until the desired colour is obtained. In this last formula, the salts are dissolved as given; that is, 10 per cent solutions are not used.

Olive green tones (Namias). Tone the prints in the usual uranium bath, then wash, and immerse in:

Ferric chloride	5 g	38.5 gr.
Hydrochloric acid	10 ccm	77 min.
Water	1000 ccm	16 oz.

Fix in the acid hypo-sodium acetate bath.

IRON OR CYANOTYPE TONING.—In this process the colour is dependent on the deposition of Prussian blue on the image, and this is soluble in alkalis; therefore, long washing in ordinary water is inadvisable.

Immerse the prints in a 5 per cent solution of potassium

ferricyanide with the addition of a little potassium oxalate, wash well, and treat with a 2 per cent solution of iron ammonium oxalate. This salt is the best to use for all iron toning baths, as it is stable and of uniform composition. Sedlaczek's formulas are as follows, and all the quantities apply to 10 per cent solutions of the salts, unless otherwise stated:

Ammonia iron alum	25 ccm	175 min.
Potassium citrate	20 ccm	140 min.
Ammonia alum, sat. sol.	100 ccm	700 min.
Hydrochloric acid	5 ccm	35 min.
Potassium ferricyanide	20 ccm	140 min.
Water	1000 ccm	16 oz.

This gives a deep blue tone.

Ammonia iron alum	25 ccm	175 min.
Potassium oxalate	60 ccm	440 min.
Ammonia alum, sat. sol.	100 ccm	700 min.
Hydrochloric acid	5 ccm	35 min.
Potassium ferricyanide	20 ccm	240 min.
Water	1000 ccm	16 oz.

This gives a cold blue. If the hydrochloric acid and alum be omitted, and 10 ccm (70 min.) of 10 per cent solution of tartaric acid be used, a grey blue colour is given.

Ammonia iron alum	100 ccm	700 min.
Potassium bromide	60 ccm	420 min.
Hydrochloric acid	10 ccm	70 min.
Water	1000 ccm	16 oz.

This gives a bright blue.

The following was specially recommended by Pfenninger for the blue constituent image in three-colour work. Immerse the print or transparency in the following solution, made by weight:

Potassium ferricyanide	30 g	230 gr.
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Sodium carbonate, cryst.	10 g	77 gr.
Ammonium nitrate	10 g	77 gr.
Salt	10 g	77 gr.
Water	1000 ccm	16 oz.

The image bleaches to a bright greyish brown, and should be then well washed, and immersed in:

Potassium bromide	5.5 g	42 gr.
Glacial acetic acid	16.5 ccm	127 min.
Ammonium iron alum	5.5 g	42 gr.
Water	1000 ccm	16 oz.

As soon as the prints have assumed a steel blue colour, they should be well washed, fixed in a 5 per cent solution of hypo, again well washed, and immersed for 2 minutes in a 1 per cent solution of sulphuric acid. The prints should be rather darker than usual, as this process reduces the density slightly.

VANADIUM TONING.—This gives green tones which vary according to the ratio of iron to the vanadium salt and the duration of the washing. The colour is dependent on the deposition of vanadium ferrocyanide, which is yellow-orange, in combination with Prussian blue; with prolonged washing some of the latter dissolves; therefore, the green becomes brighter. Namias recommended separate baths:

Potassium ferricyanide	50 g	384 gr.
Water	1000 ccm	16 oz.
Ammonia	q. s.	q. s.

Add enough ammonia to make the solution smell distinctly after shaking well. Immerse the bleached and well washed prints in a bath compounded of the following stock solutions:

A. Vanadium chloride, 2 per cent solution

B. Ferric chloride, 2 per cent solution

For use take:

A solution	125 ccm	2 oz.
B solution	125 ccm	2 oz.

Water	1000 ccm	16 oz.
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In the following, direct toning is used, a single bath being employed; the first is by Somerville:

A. Ferric chloride	2.3 g	16 gr.
Oxalic acid, sat. sol.	120 ccm	2 oz.
Vanadium chloride	4.6 g	32 gr.
Nitric acid	10.5 ccm	80 min.
Water	500 ccm	8 oz.
B. Potassium ferricyanide	2.3 g	16 gr.
Water	500 ccm	8 oz.

Mix just before use. Duration of toning 2 to 4 minutes; wash and fix in:

Hypo	200 g	2 oz.
Boric acid	40 g	200 gr.
Water	1000 ccm	10 oz.

Finally, wash for 10 minutes.

The disadvantage of the above baths is that some opaque silver chloride is formed, so that the results are somewhat muddy and control of the colour is not easy. By using vanadium oxalate or sulphate, much brighter colours and clearer prints are obtained (Wall). It is necessary to make these salts, but this is an easy task:

Ammonium metavanadate	100 g	3 oz., 130 gr.
Oxalic acid, pure	460 grs	1 lb.
Water	500 ccm	17½ oz.

Mix into a cream in a beaker or porcelain dish, and heat gradually with constant stirring. Solution gradually takes place, and the colour turns to orange and greyish-blue, but, as the heat is continued, it becomes a bright blue. Finally, add water until the bulk measures 1477 ccm (52 oz.). If the sulphate is to be used, although it presents no advantages, use:

Ammonium metavanadate	100 g	3 oz., 130 gr.
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Water	500 ccm	17½ oz.
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Mix into a cream and add slowly with constant stirring pure sulphuric acid, sp. gr. 1,845, 70 ccm (1183 min); then follow the directions given above. The actual toning bath is:

Ammonium oxalate or sulphate

solution as above	50 ccm	384 min.
Oxalic acid, sat. sol.	50 ccm	384 min.
Ammonia alum, sat. sol.	50 ccm	384 min.
Ferric oxalate, 20% sol.	q. s.	q. s.
Glycerine	50 ccm	384 min.

Potassium ferricyanide,

10% sol.	10 ccm	77 min.
Water	1000 ccm	16 oz.

Mix the oxalic acid and vanadium solutions with half the water; then add the alum solution and the ferric oxalate; mix the ferricyanide solution with the glycerine and the remainder of the water, and add to the first solution. The more ferric oxalate used, the bluer the colour; with 10 ccm (77 min.) in the above bath a bright emerald green tone is obtained. Toning takes from 10 to 15 minutes; the prints should be immersed in a 10 per cent solution of sodium sulphate for 5 minutes, and then washed for 10 minutes.

Namias suggests the following method of making vanadium chloride:

Ammonium vanadate	100 g	768 gr.
Hydrochloric acid	250 ccm	4 oz.
Water	250 ccm	4 oz.
Sodium bisulphite, dry	60 to 80 g	460 to 610 gr.

Heat until the solution turns blue and dilute to 1000 ccm (16 oz.) with water. For green tones bleach the prints in the usual ferricyanide bath, wash well, and immerse in:

Vanadium chloride, as above	25 ccm	192 min.
Ferric chloride	2.5 g	19 gr.

Ammonium chloride	100 g	768 gr.
Water	1000 ccm	16 oz.

More ferric chloride gives bluer tones. Wash and fix in an acid-hypo sodium acetate bath.

LEAD TONING.—Various colours may be obtained by bleaching prints with a lead salt and ferricyanide, and subsequent treatment with various reagents. The results are not very satisfactory; there is a very great tendency for the whites to be stained, and great intensification is given. The bleaching bath may be:

Lead acetate or nitrate	40 g	307 gr.
Glacial acetic acid	100 ccm	770 gr.
Potassium ferricyanide	60 g	460 gr.
Water	1000 ccm	16 oz.

When thoroughly bleached, the prints should be washed with three successive baths of 10 per cent nitric acid, then washed for a short time with water, and treated with one of the following baths: ammonium sulphide, 1:3, for black; Schlippe's salt, 2 per cent solution, for reddish-yellow; potassium chromate, 2 per cent, for yellow; ferric chloride for green; cupric chloride for red; uranium nitrate and ammonium chloride for red-brown; cobalt or nickel chloride for green; mercuric iodide for orange-yellow.

Lead-iron for greenish tones (Maquenne).—This is a complicated process, which is open to the same objections as above, but the prints must be rather denser than normal, as there is no intensification. Four stock solutions are required, which will keep in the dark:

A. Lead acetate	135 g	1036 gr.
Glacial acetic acid	100 ccm	768 min.
Ferric chloride, dry	15 g	115 gr.
Water	1000 ccm	16 oz.
B. Lead acetate	100 g	768 gr.

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Glacial acetic acid	100 g	768 gr.
Water	1000 ccm	16 oz.
C. Potassium ferricyanide	100 g	768 gr.
Water	1000 ccm	16 oz.
D. Ferric chloride	1.75 g	13.4 gr.
Glacial acetic acid	10 ccm	77 min.
Water	1000 ccm	16 oz.

To make A, dissolve the lead salt in the acid and water, add the iron, shake well, and filter. Blue-green tones are obtained by immersion of the prints for 5 minutes in a 2 per cent solution of glacial acetic acid and then in the following for 6 minutes:

A solution	100 ccm	1 oz.
C solution	100 ccm	1 oz.
Water	1000 ccm	10 oz.

Again immerse in the dilute acetic acid bath for a short time, wash well, transfer to a 0.5 per cent solution of citric acid, and wash for an hour. Then rub the surface gently with a pad of absorbent cotton, and immerse in:

Potassium chromate	5 to 10 g	38 to 77 gr.
Water	1000 ccm	16 oz.

The colour turns brownish-green; wash the prints, immerse in the citric acid solution, as above, and wash for a short time. Bright green tones are obtained by preliminary treatment with an acetic acid bath and immersion in:

A solution	80 ccm	614 min.
B solution	20 ccm	154 min.
C solution	100 ccm	768 min.
Water	1000 ccm	16 oz.

Then the prints must be treated with the acetic acid, chromate and citric acid baths. Pure green tones are obtained by treating the prints to a preliminary acid bath, then immersing in:

B solution	50 ccm	384 min.
C solution	50 ccm	384 min.
Water	1000 ccm	16 oz.

Without washing, transfer to the first bath given for blue-green. Rinse well and transfer to solution D. Treat with the dilute acid baths, wash well, and dry.

Green tones can also be obtained (Sedlaczek) by bleaching the prints in:

Lead nitrate	15 g	115 gr.
Nitric acid	10 ccm	77 min.
Potassium ferricyanide	1 g	7.7 gr.
Water	1000 ccm	16 oz.

Wash well, and immerse in:

Ammonia iron alum	100 g	770 gr.
Potassium bichromate, sat. sol.	50 ccm	385 min.
Potassium bromide	5 g	38 gr.
Water	1000 ccm	16 oz.

Treat the prints with a 3 per cent solution of hydrochloric acid until the whites are clean. Brighter green tones are obtained by immersion of the lead-bleached image in a 0.5 per cent solution of potassium bichromate, rinsing, and then treating with the above iron alum bath. Or blue-green tones may be obtained by using the following instead of the iron bath:

Ammonia iron alum	100 g	770 gr.
Potassium bromide	50 g	385 gr.
Water	1000 ccm	16 oz.

URANIUM AND IRON TONING (*Blake-Smith*).—This also gives blueish-green tones:

Uranium nitrate	5 g	38.5 gr.
Ammonio-citrate of iron	5 g	38.5 gr.
Nitric acid	5 g	38.5 gr.
Potassium ferricyanide	10 g	77 gr.

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Water	1000 ccm	16 oz.
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Or the following (Eder) :

Uranium nitrate	5 g	38.5 gr.
Ammonio-citrate or iron	5 g	38.5 gr.
Glacial acetic acid	200 ccm	3¼ oz.
Water	1000 ccm	16 oz.

COBALT TONING (*Somerville*).—Greenish or green-blue tones are obtained by this process, but they are very unsatisfactory. Bleach the image in :

Potassium bichromate	60 g	460 gr.
Potassium ferricyanide	300 g	5¼ oz.
Water	1000 ccm	16 oz.

Then wash until free from any yellow stain, and immerse in :

Cobalt chloride	25 g	192 gr.
Ferrous sulphate	6 g	46 gr.
Hydrochloric acid	200 ccm	3¼ oz.
Water	1000 ccm	16 oz.

Replacement of the hydrochloric by glacial acetic acid gives brighter green tones. The prints should be fixed in :

Hypo	250 g	4 oz.
Boric acid	45 g	345 gr.
Water	1000 ccm	16 oz.

Dissolve by heat, and use when cold. Wash the prints well.

Or bleach the image in :

Potassium ferricyanide	60 g	460 gr.
Lead nitrate	40 g	307 gr.
Water	1000 ccm	16 oz.

Wash thoroughly, and immerse in :

Cobalt chloride	100 g	768 gr.
Hydrochloric acid	30 ccm	230 min.
Water	1000 ccm	16 oz.

GOLD AND PLATINUM TONING (*Somerville*).—Gold toning is sometimes resorted to, more to improve the colour of prints

than to obtain warm tones; and greenish or rusty prints can be improved by placing them face up, as they come from the washing after fixing, on a sheet of glass, dabbing into flatness with a clean pad of linen, and brushing over with:

Ammonium sulphocyanide	20 g	154 gr.
Gold chloride	1 g	7.7 gr.
Hot water	1000 ccm	16 oz.

Use when cold. A soft flat brush, without metal binding, should be used. When the desired improvement is reached, that is, when the image becomes black or blue-black, wash well, and dry. Purple blacks can be obtained by bleaching the prints first in:

Cupric sulphate	25 g	192 gr.
Potassium bromide	25 g	192 gr.
Water	1000 ccm	16 oz.

Rinse, and immerse for 5 minutes in 5 per cent nitric acid, wash, and tone in:

Ammonium sulphocyanide	8 g	61 gr.
Ammonia	3 ccm	23 min.
Gold chloride	2.3 g	18 gr.
Water	1000 ccm	16 oz.

Toning takes from 10 to 20 minutes, and the more ammonia used, the deeper the tone.

Platinum toning gives warm sepias, but the results are not permanent. The following may be used (Heatherly):

Potassium oxalate	160 g	1228 gr.
Mercuric chloride	13 g	100 gr.
Potassium citrate	20 g	154 gr.
Citric acid	40 g	307 gr.
Water	1000 ccm	16 oz.

Mix, and add just before use:

Potassium chloroplatinite	2.7 g	20.7 gr.
Hydrochloric acid	2.7 ccm	21 min.

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Water	1000 ccm	16 oz.
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When the desired tone is obtained, wash well, and dry; slightly darker tones are obtained if the print is immersed in a 2 per cent solution of sodium carbonate.

The following is stated to be suitable for bromide but not development (gaslight) prints:

Mercuric chloride	2 g	16 gr.
Potassium chloroplatinite	4 g	32 gr.
Citric acid	18 g	138 gr.
Water	1000 ccm	16 oz.

This should be made up fresh, and gives warm sepias with slight staining of the high lights. For cold sepia tones, with absence of staining of the whites, add potassium bromide 1 g (8 gr.) to the above. Wash well after toning.

SELENIUM TONING.—This gives various shades of sepia to purplish-red tones (Miliani):

Powdered selenium	2 to 10 g	15.4 to 77 gr.
Sodium sulphide	100 g	768 gr.
Water	1000 ccm	16 oz.

Heat the solution till the selenium dissolves, and dilute as required for use. The weaker the bath, the more sepia the colour. On diluting the bath, some selenium is thrown down, and the solution should be filtered, or the prints after toning passed through two or three baths of 1 per cent solution of sodium sulphide. Another (Valenta):

Selenium	16.5 g	127 gr.
Sodium sulphide	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.

Heat until dissolved, dilute with 5 to 6 times the volume of water, and add pyrocatechin, 1 per cent solution, 20 to 40 ccm to every liter or 154 to 307 min. to 16 oz. If the whites are tinged, pass the prints through weak baths of acid sulphite of soda.

According to Mimosa, if the selenium bath be neutralised with boric acid, there is no precipitation of the selenium; the addition of ammonia reduces the staining of the whites, which may be removed by a 10 per cent solution of potassium metabisulphite.

Namias recommends to fuse in a nickel or iron crucible 2 parts of granular selenium with 10 to 15 parts of caustic soda, and, when cold, dissolve in 100 parts of water. The toning bath is:

Sodium selenide, thus made	100 ccm	768 min.
Sodium sulphide	50 g	384 gr.
Water	1000 ccm	16 oz.

Bleach the prints in the usual way, and then tone in this solution. A combined toning and fixing bath may be prepared by mixing:

Hypo	66 g	500 gr.
Sodium selenide, as above	a few drops	a few drops
Water	1000 ccm	16 oz.
Boric acid	40 g	307 gr.

Dissolve the hypo and the acid in hot water, and add the selenium solution when cold. Better sepia tones are obtained with the following:

Powdered selenium	2 parts
Sodium sulphide	50 parts

Fuse together and dissolve in 150 parts of water. To make the bath, add a few drops of this stock solution to a 2 per cent solution of sodium sulphide. All selenium salts have an intense garlic odor, which is very lasting.

MOLYBDENUM TONING (*Namias*).—This gives a deep blue tone:

Molybdic acid	100 g	2 oz.
Ammonia	250 ccm	5 oz.
Water	250 ccm	5 oz.

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When dissolved, pour into:

Nitric acid	500 ccm	10 oz.
Water	500 ccm	10 oz.

To make the bath use:

Molybdate solution above	250 ccm	4 oz.
Water	1000 ccm	16 oz.
Potassium metabisulphite	50 g	384 gr.

This should be used in artificial light, and the prints well washed.

TONING BY REDEVELOPMENT (*Manly*).—Various tones can be obtained by bleaching prints with the following baths and redeveloping with the given developers:

A. Potassium ferricyanide	33 g	250 gr.
Ammonium bromide	40 g	310 gr.
Water	1000 ccm	16 oz.
B. Cupric sulphate	50 g	384 gr.
Sulphuric acid	6.5 ccm	50 min.
Common salt	50 g	384 gr.
Water	1000 ccm	16 oz.
C. Potassium bichromate	20 g	154 gr.
Sulphuric acid	50 ccm	384 min.
Salt	100 g	768 gr.
Water	1000 ccm	16 oz.

After bleaching in one of the baths, the prints should be washed for 20 to 30 minutes, and redeveloped in the following:

I. Metol	10 g	77 gr.
Sodium sulphite, dry	33 g	250 gr.
Sodium carbonate, dry	33 g	250 gr.
Water	1000 ccm	16 oz.
II. Hydrochinon	33 g	250 gr.
Potassium metabisulphite	16 g	123 gr.
Water	1000 ccm	16 oz.

III. Ammonium carbonate	100 g	768 gr.
Water	1000 ccm	16 oz.

The tones are somewhat dependent on the make of paper, but the following will give a general idea of the tones obtainable. Bleach in A; develop in equal parts of II and III, diluted with more or less water; rich purplish-brown tones are obtained. Bleach in equal parts A, B, C; develop in I; result, good blacks slightly wanting in depth. Bleach in B; develop in I; splendid velvety blue-blacks in the shadows, like carbon paper. Bleach in C; develop in 4 parts II, 6 parts III and 2 parts water; distinct intense brown with pure whites. Bleach in C; develop in 1 part II, 1 part III, 1 part water; a good sepia, like sulphur toning. Bleach in C; develop in 2 parts II, 1 part III and 2 parts water; result, a bright brown.

Sulphide Toning

There are two principal methods of obtaining warm brown or sepia to purplish brown tones: the direct and the indirect. In the former, the image is converted into silver sulphide direct, while in the latter process the silver is first converted into chloride, bromide or iodide, and then into sulphide.

DIRECT PROCESSES.—*Alum and hypo (Baekeland).—*

Hypo	200 g	3 1/5 oz.
Potash alum	46 g	354 gr.
Water	1000 ccm	16 oz.

Dissolve the hypo, keeping the temperature of the solution near the boiling point, add the alum gradually with constant stirring, and allow to cool. Heat up to 50° to 60° C. (122° to 140° F.) each day for three days, and then add:

Silver nitrate, 10% sol. 5 to 7 ccm 40 to 55 min.

The bath must not be filtered.

Alum-sugar-hypo (Baekeland).—

Hypo	25 g	192 gr.
White sugar	40 g	307 gr.
Alum	25 g	192 gr.
Hot water	1000 ccm	16 oz.

Mix as above. It is advisable to wash the prints thoroughly after fixing, and with some papers it is advisable also to immerse for 5 minutes in an alum bath, then briefly wash and tone. The bath should never be above 44° C. (110° F.), the best results being obtained at about 32° C. (90° F.), though toning at this temperature takes 30 minutes.

*Alum and hypo (Artura).—*Specially recommended for development (gaslight) papers, but equally suitable for bromide prints:

A. Hypo	125 g	2 oz.
Potash alum	31 g	$\frac{1}{2}$ oz.
Hot water	1000 ccm	16 oz.
B. Silver nitrate, 10% sol.	10 ccm	77 min.
Salt, 10% sol.	10 ccm	77 min.

As soon as A has cooled down, add B with constant stirring. The best temperature is 31° C. (88° F.), and toning takes from 15 to 30 minutes.

Alum-gold-hypo (Artura).—

Hypo	62.5 g	1 oz.
Potash alum	15.5 g	$\frac{1}{4}$ oz.
Sodium phosphate	15.5 g	$\frac{1}{4}$ oz.
Hot water	1000 ccm	16 oz.

Dissolve the salts in the order given. Add, when the solution is cold :

Silver nitrate, 10% sol.	10 ccm	77 min.
Potassium bromide, 10% sol.	10 ccm	77 min.

Finally, add :

Gold chloride, 1% sol.	13 ccm	100 min.
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The working temperature should be 35° to 39° C. (95° to 102° F.).

When hot toning baths are used, the prints should be allowed to cool before washing; otherwise blisters are very likely to form.

Colloidal sulphur (Lumière).—

Hypo	125 g	2 oz.
Hot water	1000 ccm	16 oz.

Dissolve, and add :

Yellow dextrine, 50% sol.	250 ccm	4 oz.
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And, shortly before use, add :

Hydrochloric acid, pure	50 ccm	384 min.
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The bath will not keep more than about 2 hours. Prints should be immersed in the bath at a temperature of 18° to

20° C. (65° to 68° F.) for 20 to 35 minutes, and apparently no change takes place; but, if washed for 1½ hours, the sepia tone makes its appearance.

*Liver of sulphur or polysulphide process (Woodman).—*Wash the prints free from hypo, harden by immersion in formaldehyde solution, and place at once in a solution of liver of sulphur (sulphurated potash) made by dissolving a piece about the size of a pea in 200 ccm (7 oz.) water.

*Ammoniacal liver of sulphur (Vero).—*The prints must be free from hypo and must not have been dried. Harden by 10 minutes' immersion in a 10 per cent solution of formaldehyde, wash, and immerse in:

Liver of sulphur	7 g	54 gr.
Water	1000 ccm	16 oz.
Ammonia	a few drops	

Toning is very rapid and purplish-brown tones are obtained.

Ammonium sulphide (Kropf).—

A. Ammonium sulphide	25 ccm	192 min.
Water	1000 ccm	16 oz.
B. Ammonium carbonate	3.75 g	29 gr.
Water	125 ccm	2 oz.
C. Ammonium persulphate	1.25 g	10 gr.
Water	125 ccm	2 oz.

Mix in the above order. The colour of the mixture should be greenish-yellow, and, in about half an hour, turn to golden yellow, when it is ready for use. Prints should be washed for a short time after fixing, and then immersed in the bath at normal temperature; toning takes about 15 minutes. If heated to 30° C. (86° F.), toning is complete in 10 minutes.

Sodium sulphide-ferricyanide (Brown).—

Sodium sulphide, 20% sol.	400 ccm	8 oz.
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Potassium ferricyanide,

20% sol.	200 ccm	4 oz.
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The mixture turns milky, but clears up on stirring well.

Then add:

Potassium bromide, 10% sol.	200 ccm	4 oz.
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Glacial acetic acid	50 ccm	½ oz.
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Stir until the precipitate dissolves. The prints should be well washed, and, in from 10 to 15 minutes after immersion in the bath, assume a very pleasing brown tone.

Sulphide-ferricyanide (Blake-Smith).—Three stock solutions are required:

A. Sodium sulphide, pure	100 g	4 oz.
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Water	400 ccm	16 oz.
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B. Sulphuric acid, pure	25 ccm	1 oz.
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Water	250 ccm	10 oz.
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C. Potassium ferricyanide	50 g	1 oz.
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Water	500 ccm	10 oz.
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For use mix:

A solution	60 ccm	460 min.
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Water	1000 ccm	16 oz.
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Then add:

B solution	180 ccm	2 oz., 6 dr.
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And, finally, add:

C solution	500 ccm	8 oz.
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Toning should be complete in from 2 to 5 minutes.

Ammonium sulphide-ferricyanide.—

A. Potassium bromide	11 g	85 gr.
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Potassium ferricyanide	35 g	269 gr.
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Water	1000 ccm	16 oz.
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To this, add:

B. Ammonium sulphide	25 ccm	192 min.
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Water	100 ccm	1½ oz.
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This last solution should be mixed just before use.

Thiocarbamide-sulphide (Triepel).—

Potassium bromide	10 g	77 gr.
Potassium ferricyanide	15 g	115 gr.
Sodium sulphide	4 g	31 gr.
Thiocarbamide	2 g	15.5 gr.
Caustic soda	2 g	15.5 gr.
Water	1000 ccm	16 oz.

INDIRECT PROCESSES.—The bleaching bath may be made either with a bromide, chloride or iodide. The correct formula for the bromide is:

Ammonium bromide	11 g	85 gr.
For the chloride		
Salt	6.6 g	50 gr.
For the iodide:		
Potassium iodide	18.6 g	143 gr.
Each should be added to:		
Potassium ferricyanide	35 g	269 gr.
Water	1000 ccm	16 oz.

If the halide salts be used in the above quantities, there is no loss in the intensity of the images, which will be the case if they are used stronger. The above may be kept as stock solutions. The following gives a somewhat colder sepia than the above:

Potassium ferricyanide	6 g	46 gr.
Ammonia	15 ccm	115 min.
Water	1000 ccm	16 oz.

Various modifications have been suggested, as:

Potassium ferricyanide	23 g	177 gr.
Potassium iodide	14 g	107 gr.
Ammonium persulphate	14 g	107 gr.
Water	1000 ccm	16 oz.

Or:

Potassium iodide	23 g	177 gr.
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Iodine	10 g	77 gr.
Water	1000 ccm	16 oz.

In these last two baths the paper turns a deep blue, which may be discharged by immersion in a 2 per cent solution of potassium metabisulphite or sodium sulphite acidulated with a little sulphuric acid.

The following was recommended (Greenall) for commercial work, as it saves the cost of the halides:

Potassium ferricyanide	23 g	177 gr.
Sodium phosphate	115 g	883 gr.
Water	1000 ccm	16 oz.

Bichromate baths have been recommended, but they require much longer washing to remove the yellow bichromate stain than the other baths. Sedlacek's formula is:

Potassium bichromate,		
sat. sol.	100 ccm	1 oz.
Hydrochloric acid, 10% sol.	100 ccm	1 oz.
Potassium bromide	100 g	1 oz.
Water	1000 ccm	10 oz.

Blake-Smith recommended:

Potassium bichromate	21 g	160 gr.
Sulphuric acid	40 ccm	307 min.
Salt	100 g	768 gr.
Water	1000 ccm	16 oz.

Too long washing of the bleached prints causes yellow tones; about 10 minutes in running water is enough. The toning solution is sodium sulphide, and the best results are obtained with the hydrated salt (pure analytical agent). Ordinary technical sulphide should be made into a stock solution and boiled for a short time until a black precipitate forms, or allowed to stand for several days, and then filtered. Old deliquesced salt should not be used, as it consists in great part of hypo and caustic soda, which reduce the strength of the

print and cause blisters. A stock solution that will keep (Blake-Smith) can be made as follows:

Sodium sulphide	330 g	5 oz.
Sodium sulphite, dry	50 to 65 gr.	$\frac{3}{4}$ to 1 oz.
Water	1000 ccm	15 oz.

For use dilute with 9 volumes of water. The bath should not be used too long.

Ammonium or barium sulphide may be used instead of the sodium compound:

Ammonium sulphide	10 to 20 ccm	77 to 154 min.
Water	1000 ccm	16 oz.

Or:

Barium sulphide	3.3 g	25 gr.
Water	1000 ccm	16 oz.

Shake the latter solution for a few minutes and allow to stand for any precipitate to settle, and then filter. The barium salt is more stable than the sodium and therefore preferable in practice.

For chlorising or bromising the image, quinone has been recommended (Lumière & Seyewetz):

Quinone	5 g	38½ gr.
Sodium chloride (salt)	6 g	46 gr.
Sulphuric acid	3 ccm	23 min.
Water	1000 ccm	16 oz.

Potassium bromide 11 g (85 gr.) may be used instead of the sodium chloride. The bleached images are amenable to exactly the same treatment as all other bleached images.

Molybdenum and tin sulphur compounds, called sulpho- or thiomolybdates and stannates have been proposed (Smith); the former was introduced commercially as "Cubrome" and gives excellent results. This solution can be made as follows:

Ammonium molybdate	100 g	770 gr.
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Hot water	1000 ccm	16 oz.
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When cold, add in small quantities with constant stirring, ammonium sulphide sufficient to form a deep orange solution. For use mix:

Stock solution	100 ccm	770 min.
Ammonia	10 ccm	77 min.
Water	1000 ccm	16 oz.

If the whites of the prints are stained yellow, immerse for a short time in a 3 per cent solution of ammonia, and wash thoroughly. This gives excellent results with the bichromate bleaches.

Sodium sulphostannate may be prepared as follows:

Sodium sulphide, pure	30 g	230 gr.
Water	1000 ccm	16 oz.
Stannic sulphide	70 g	538 gr.

Dissolve the sodium salt in about one-fourth of the water, add the tin salt, and heat gently with constant stirring until dissolved; then dilute to bulk. Stannic sulphide is known also as tin disulphide, or bisulphide, or mosaic gold. One part of the above solution should be diluted with 9 parts of water for use.

Sulphides plus developer.—This method gives somewhat darker tones, as some black metallic silver is probably formed with the sulphide. The prints should be bleached as usual (Greenall), and then treated with the following:

Metol	1 g	7.7 gr.
Potassium carbonate	13.5 g	100 gr.
Sodium sulphide, 1% sol.	3 to 5 ccm	23 to 40 min.
Water	1000 ccm	16 oz.

This gives a warm black, which varies with increase of the sulphide.

Valenta's method requires three stock solutions:

A. Pyrocatechin	20 g	154 gr.
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Sodium sulphite, dry	50 g	384 gr.
Water	1000 ccm	16 oz.
B. Sodium carbonate, cryst.	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.
C. Schlippe's salt	10 g	77 gr.
Water	1000 ccm	16 oz.

For use mix 2 parts A with 1 part B, and for sepia tones add 2 per cent C; for warm brown tones add 4 percent C.

Toning with mercury sulphides.—In this method the variation of colour depends on the addition of more or less mercury salt to the image (Bennett). Two stock solutions are required for the bleaching bath:

A. Ammonium bromide	11 g	85 gr.
Potassium ferricyanide	35 g	269 gr.
Water	1000 ccm	16 oz.
B. Mercuric chloride	28 g	215 gr.
Potassium bromide	28 g	215 gr.
Hot water	1000 ccm	16 oz.

And two stock solutions for the toning bath:

I. Sodium sulphide	330 g	5 1/3 oz.
Sodium sulphite, dry	50 to 65 g	385 to 500 gr.
Water	1000 ccm	16 oz.
II. Schlippe's salt	10 g	77 gr.
Water	1000 ccm	16 oz.

The following table gives the colours obtainable with the various baths:

	Bleacher	Toning bath
Black	A, 1; B, 1	I
Brown black	A, 2; B, 1	I
Deep brown	A, 3; B, 1	I
Dark brown	A, 5 to 7; B, 1	I
Deep warm brown	A	I
Reddish brown	A	I, 1; II, 7

Red brown	A	I, 1; II, 4
Very warm brown	A	I, 1; II, 2
Red chalk	A	II

Schlippe's salt is also known as sodium sulphantimoniate. The crystals should be rinsed with water before use, and a drop or two of ammonia added to the stock solution.

Various tones may also be obtained with mercury salts by the following baths. Bleach the prints in:

Mercuric chloride	12 g	92 gr.
Potassium bromide	12 g	92 gr.
Water	1000 ccm	16 oz.

Wash thoroughly, and use the following baths for the various colours:

Greyish-black:

Hypo	10.5 g	80 gr.
Water	1000 ccm	16 oz.

Grey-violet:

Hypo	10.5 g	80 gr.
Potassium metabisulphite	5.25 g	40 gr.
Water	1000 ccm	16 oz.

Brown to violet-black:

Hypo	18.75 g	144 gr.
Cupric sulphate	18.75 g	144 gr.
Water	1000 ccm	16 oz.

The addition of a few grains of sodium carbonate gives darker tones.

Brownish-violet:

Hypo	12.5 g	96 gr.
Silver nitrate	4.2 g	32 gr.
Sodium metabisulphite	6.25 g	48 gr.
Water	1000 ccm	16 oz.

It should be noted that all mercury toning gives intensification.

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Sulphide and Schlippe's salt.—Variation of colour may be obtained by combining sodium or ammonium sulphide with Schlippe's salt (Bishop). Ten per cent solutions of sodium sulphide and Schlippe's salt should be made, or the commercial solution of ammonium sulphide may be used. For red-brown tones mix:

Sulphide solution	25 ccm	192 min.
Schlippe's salt solution	75 ccm	576 min.
Water	1000 ccm	16 oz.

For warm brown:

Sulphide solution	50 ccm	384 min.
Schlippe's salt solution	50 ccm	384 min.
Water	1000 ccm	16 oz.

For brown tones:

Sulphide solution	75 ccm	576 min.
Schlippe's salt solution	25 ccm	192 min.
Water	1000 ccm	16 oz.

Carminc or red chalk tones.—These can be easily procured by treatment of a sulphide toned print with gold sulphocyanide:

Gold chloride	2.3 g	15 gr.
Ammonium sulphocyanide	23 g	150 gr.
Water	1000 ccm	16 oz.

The following (Blake-Smith) acts better:

A. Gold chloride	1 g	15 gr.
Water	225 ccm	7 oz.
B. Thiocarbamide	3.25 g	23 gr.
Water	1000 ccm	16 oz.
C. Sulphuric acid	10 ccm	77 min.
Water	1000 ccm	16 oz.

For use mix 1 part each of A, B and C with 10 parts water. Allow the action to continue until the deepest shadows are toned.

Reducing sulphide-toned prints.—Sulphide toned prints may be reduced by treatment with most of the usual negative reducers or with chlorine and bromine water, solutions of iodide, permanganate, and sulphuric acid. The most satisfactory are solutions of cupric chloride or bromide, the latter for preference (Smith). The chloride reducer is equal parts of a 5 per cent solution of cupric chloride and a 15 per cent solution of common salt. The bromide reducer is:

Cupric bromide	7.5 g	58 gr.
Sodium bromide	62.5 g	480 gr.
Water	1000 ccm	16 oz.

The cupric bromide in this bath may be replaced by using 8.5 g (65 gr.) cupric sulphate, and increasing the sodium bromide by 8 g (61 gr.). After reduction the prints should be immersed for 2 minutes in a 5 per cent solution of hydrochloric acid, and washed for about 10 minutes.

Partial development and sulphiding.—Bleach the prints in the usual ferricyanide and bromide mixture, wash for 90 seconds in running water, and immerse for various times in the following developer; rinse for 30 seconds, and treat with the usual sulphide bath.

Metol	1.8 g	14 gr.
Hydrochinon	4.6 g	35 gr.
Sodium sulphite, dry	9.2 g	70 gr.
Borax	18.4 g	140 gr.
Water	1000 ccm	16 oz.

The following table shows the various tones obtained:

Print No.	Time in Developer	Colour on removal from Developer	Resulting colour of finished print	Remarks
1.				
2.	Until blackened		Black	Normal print
3.	30 minutes	Chocolate red with tinge of violet	Warm black	Full strength developer used and no sulphiding
4.	20 minutes	Chocolate red	Warm black to brown black	The most useful range
5.	15 minutes	Red	Cool sepia	
6.	12 minutes	Lighter red	Mezzotint sepia	
7.	9 minutes	Pale red	Sepia	
8.	6 minutes	Very pale red	Warm sepia	
Print No.	First Bath	Second Bath	Third Bath	Remarks
9.	Presulphide for 5 min.	Bleach	Warm sepia with dis-tinct tinge of yellow Sulphide	Intermediate between 10 and 11
10.	Bleach	10 sec. in sodium carbonate	Sulphide	Most yellow
11.	Presulphide for 5 min.	Bleach	10 sec. in sodium carbonate	Least yellow

GENERAL NOTES ON SULPHUR TONING.—R. Bullock of the Kodak Research Laboratory, finds that the character of the emulsion has considerable influence on the resulting colour; the faster the emulsion the more purple the colour, while slow papers tend to give yellowish tones. Also, with a given paper, the degree of development exerts some action, although this may be masked by the character of the emulsion. With a given paper and method of making the black and white print, the hypo-alum and liver of sulphur (potassa sulphurata) toning processes give practically identical results, while the indirect methods, that is, those in which the image is bleached first, tend to give yellowish prints. The effect of a preliminary treatment of the black and white print with sulphide, prior to bleaching, is to give mixed direct and indirect sulphide toning; the results depending on the exact procedure followed, and, therefore, varying in colour. In the indirect process there is no advantage in increasing the ratio of the bromide to more than one-third of the ferricyanide. With 10 per cent of ferricyanide, the colour is more yellowish and the bleaching very rapid; with from 3 to 1 per cent, the bleaching is practically no longer and the colours normal: with much less than 1 per cent, bleaching is much slower but the colour just as good. The most advisable strength would thus appear to be 3 per cent, or 30 g ferricyanide per liter (230 gr. to 16 oz.) with 10 g (77 gr.) ammonium bromide respectively. No advantage is to be found by the use of chlorides, while with iodides the tones are more yellowish. For the sulphide bath, a strength of 3 per cent is the best, and the bath should be unsparingly used so as not to exhaust it. Dipping the prints for about 10 seconds into a 1 per cent solution of sodium carbonate, immediately before the sulphide bath, tends to give more purplish tones, particularly with development papers, and when a chloride bleach is

used. The final conclusions are that: excessive bromide in the bleach leads to loss of image; too long washing after bleaching should be avoided, as well as weakness or too long use of the sulphide bath, and presence of hypo in the latter.

The Carbon Process

MAKING THE TISSUE.—The gelatine mass is prepared with hard and soft gelatine in the ratio of 3:1, or the finest pale carpenter's glue may be used, with an admixture of sugar candy; in very hot dry climates a little glycerine. The latter addition is not advisable under ordinary circumstances. A typical formula is:

Gelatine	200 g	3½ oz.
Sugar candy	50 g	384 gr.
Water	1000 ccm	16 oz.
Colouring pigment	4 to 10 g	30 to 77 gr.

Soak the gelatine and candy in the water for about 30 minutes and melt on a water bath. The pigment should be the finest powder colours, as used by artists. It should be worked up with a muller on a sheet of glass with a little of the gelatine solution, and added to the remainder of the solution, well stirred and strained through linen.

THE COLOURS.—The colours can be mixed in various proportions, so that any shade may be obtained, and these should be judged by their appearance when mixed with a little of the gelatine solution and dried.

Chocolate brown.—Indian ink 6, English red 4, alizarin 1, dissolved in a little soda solution, purpurine 1 part.

Engraving black.—Lamp black 19, carmine lake 10, indigo 10 parts.

Warm black.—Lamp black 6, carmine lake 6, burnt umber 4, indigo 2 parts.

Dark brown.—Indigo 2½, Indian red 6, carmine 1¼, Vandyke brown 4, lamp black 30 parts.

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Red brown.—Indian ink 6, carmine 8, Vandyke brown 8 parts.

Sepia.—Lamp black 4, sepia 35 parts.

Pure black.—Indian ink 15, Vandyke brown 2, Venetian red 2 parts.

Violet black.—Indian ink 20, indigo 2, carmine 1 part.

Red chalk.—English red 10, Italian red 5, lamp black 0.03 parts.

Transparency tissue for enlarged negatives, and positives.—Indian ink 2, Indian red 3, carmine lake 5 parts.

TO COAT BY HAND.—Strain the warm mixture into a flat dish standing in warm water, and clear the bubbles off the surface with a strip of paper or thin card. Hold the paper to be coated upright at the further end of the dish, its lower edge just touching the liquid, and gently lower it on to the surface. Float for 2 minutes, and raise with a steady motion; allow to drip and hang up to dry.

SENSITISING.—Either ammonium or potassium bichromate may be used:

Potassium bichromate	21 to 63 g	160 to 480 gr.
Water	1000 ccm	16 oz.
Ammonia	q. s.	q. s.

Enough ammonia should be used to make the solution smell distinctly. For weak negatives use the weakest bath, for normal negatives the mean, and for harsh negatives the strongest bath. Immerse the tissue for 3 minutes, and dry in the dark. The temperature of the solution should be 15° C. (60° F.)

The following gives a tissue that will keep better:

Potassium bichromate	20 g	240 gr.
Citric acid	5 g	60 gr.
Ammonia	q. s.	q. s.

Water	1000 ccm	25 oz.
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Use as above.

QUICK-DRYING SENSITISER.—This is convenient, as the tissue will readily dry in from 15 to 30 minutes.

Ammonium bichromate	60 g	460 gr.
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Water	1000 ccm	16 oz.
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Immediately before use mix 2 parts of the above with 3 parts of alcohol or acetone. The tissue may be immersed in this for 3 to 4 minutes, or the solution may be painted on freely. The alcoholic mixture will not keep.

SINGLE TRANSFER PAPER.—Brush over plain paper:

Soft gelatine	60 g	460 gr.
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Water	875 ccm	14 oz.
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Soak the gelatine for 30 minutes, dissolve in a water bath, and raise nearly to the boiling point; add with constant stirring:

Chrome alum	1.25 g	10 gr.
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Water	125 ccm	2 oz.
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The mixture must be rapidly used and kept hot, or it will gelatinise. The following may be easily applied with a broad flat brush and dries rapidly:

Soft gelatine	7 g	54 gr.
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Glacial acetic acid	35 ccm	270 min.
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Water	275 ccm	4½ oz.
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Soak the gelatine in the acid and water for 30 minutes, and dissolve by heat; add slowly with constant stirring:

Alcohol	680 ccm	11½ oz.
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Then add in the same way:

Chrome alum	1.6 g	12¼ gr.
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Water	14 ccm	110 min.
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This solution will keep.

FLEXIBLE TEMPORARY SUPPORT.—Gelatinised paper is coated with a resinous solution. As a rule, a baryta-coated

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paper is used, either matt or glossy, which may be prepared as follows :

Gelatine	100 g	13¼ oz.
Barium sulphate	30 g	230 gr.
Glycerine	5 ccm	38 min.
Water	940 ccm	14 oz.

Soak the gelatine in water, dissolve by heat, and add the baryta rubbed into a cream with the glycerine. Add very carefully, almost drop by drop, with constant stirring :

Chrome alum	1.6 g	13 gr.
Water	60 ccm	2 oz.

Paint the mixture thickly over the paper, or else float it twice, hanging up by opposite ends each time. Obviously, single transfer or commercial baryta paper may be used.

WAXING SOLUTION.—The temporary support has to be waxed prior to use, and the following may be used :

Beeswax	20 g	154 gr.
Powdered resin	20 g	154 gr.
Turpentine	1000 ccm	16 oz.

Melt the wax in a water bath, add the resin, and stir until dissolved; then add the turpentine gradually with constant stirring. This takes from 12 to 24 hours to dry; if ether be substituted for the turpentine, it will dry in a few minutes.

Caution.—The water in the bath should boil, and then the gas be turned out, as the vapours of both turpentine and ether are explosive. This should be applied to the paper with a pad, polished off with a dry pad, and then hung up to dry.

ALUM BATH FOR DISCHARGING BICHROMATE STAIN.—

Alum	62.5 g	1 oz.
Water	1000 ccm	16 oz.

COLLODION FOR DOUBLE TRANSFER FROM OPAL.—This gives an extremely fine matt surface, without any glaze, if

matt surface glass be used; if polished opal be used, a high gloss is obtained:

Pyroxyline	8.5 g	65 gr.
Alcohol	500 ccm	8 oz.
Ether	500 ccm	8 oz.

OPAL GLASS, IVORY OR WOOD AS FINAL SUPPORT.—Coat with the chrome gelatine mixture given above under single transfer paper. For canvas, the surface paint should be removed by scrubbing with hot soda solution, about 10 per cent, until nothing but the priming is left. Paint freely with the chrome-gelatine mixture, dry thoroughly, rub down smooth with fine sandpaper, and repeat the operations about four times. The print should be finally soaked in the gelatine solution, and squeegeed into contact.

SUBSTRATUM FOR TRANSPARENCIES.—Either of the following may be used:

Gelatine	40 g	307 gr.
Water	1000 ccm	16 oz.
Potassium bichromate	4 g	31 gr.

Coat the glass thinly, dry, and expose to light for 30 minutes; then wash and dry. Or the glass may be coated with the following, which keeps well:

Gelatine	7 g	54 gr.
Glacial acetic acid	34 ccm	260 min.
Water	270 ccm	4¼ oz.

Dissolve by heat, and add slowly:

Alcohol	680 ccm	11 oz.
Phenol (carbolic acid)	10 ccm	77 min.

Then add, with constant stirring:

Chrome alum	0.75 g	5¾ gr.
Water	14 ccm	107 min.

TO INTENSIFY CARBON TRANSPARENCIES.—Immerse in:

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Potassium permanganate	5 g	38 gr.
Water	1000 ccm	16 oz.

Rinse and dry. Weak solutions of acid aniline dyes may also be used, about 0.5 per cent. By the use of the latter it is possible to alter the colour in any desired manner.

The Gum-Bichromate Process

PIGMENTS FOR GUM-BICHRIMATE (*Kosel*).—Powder or tempera colours should be used.

Warm brown: Bone black, 5 parts; Vandyke brown, 3 parts; ivory black, 2 parts; Indian red, 1 part.

Purple brown: Ivory black, 5 parts; Vandyke brown, 4 parts; dark alizarin lake, 2 parts; Indian red, 1 part.

Yellowish brown: Ivory black, 5 parts; bone black, 5 parts; burnt sienna, 1 part.

Dark brown: Bone or ivory black alone.

Brown (for sunset effects): Bistre.

Brown, medium shade: Bone black, 5 parts; Vandyke brown, 4 parts; burnt sienna, 1 part; Indian red, 1 part.

Bright brown: Bone black, 5 parts; Vandyke brown, 4 parts; sienna, 4 parts.

Deep brown: Ivory black, 5 parts; Vandyke brown, 3 parts; Indian red, 1 part.

Blue: Ivory or peach black, 5 parts; indigo, 5 parts; Paris blue, 1 part.

Dark green: Bone black, 5 parts; Paris blue, 2 parts.
Or: Bone black, 5 parts; indigo, 5 parts; blue black, 5 parts; Paris blue, 1 part; cadmium yellow, 1 part.

Bright green: Vandyke brown, 3 parts, Paris blue, 1 part.

Olive green: Sienna, 2 parts; indigo, 2 parts; bone black, 5 parts.

Red: Ivory black, 5 parts; burnt sienna, 2 parts; Indian red, 2 parts.

Warm red: Bone black, 5 parts; red chalk, 3 parts; Indian red, 1 part.

Dark red: Peach black, 2 parts; alizarin lake, 1 part; Indian red, 1 part.

Black, for pencil drawings: Graphite.

Black: Peach or blue black.

Warm black: Ivory black.

ARABIN GUM-BICHROMATE PROCESS.—The best Soudan gum arabic should be sifted through a 40 mesh sieve. Take:

Hydrochloric acid	7.5 ccm	127 min.
Water	150 ccm	5¼ oz.

Heat to 50° C. (122° F.), sift in 100 g (3½ oz.) of the gum, and stir until dissolved; then add methyl alcohol, 600 ccm (21 oz.), and stir until the arabin is precipitated. Filter through linen, and squeeze out as much alcohol as possible. Then break up the lump, put in jar, and cover with fresh alcohol; leave for some hours with constant stirring until all the water has been absorbed by the alcohol. Squeeze dry, spread out to thoroughly dry, and powder. To make the coating mixture, take:

Arabin	20 g	300 gr.
Magnesium carbonate	20 g	300 gr.
Water	40 to 75 ccm	1½ to 2¼ oz.

The quantity of water depends on the thickness of the solution desired. Mix the pigment of the desired colour with the above until a thick cream is formed, add an equal volume of 15 per cent solution of ammonium bichromate, and spread on paper. Development is effected in the usual way with water at about 35° C. (95° F.).

FORMULA FOR PURE WHITES.—Frequently pure whites are difficult to obtain with this process, and the following is said to obviate this trouble:

Potassium bichromate	72 g	550 gr.
Water	450 ccm	7½ oz.

Dissolve by heat, add enough ammonia to make the solution

smell distinctly, and then heat to drive off excess of ammonia. Beat the whites of several eggs to a froth, and allow to stand for 24 hours to liquefy. The pigmenting solution is:

Bichromate sol., above	450 ccm	7½ oz.
Cupric sulphate	90 g	720 gr.
Gum arabic, powdered	800 g	13¼ oz.
Pigment	600 g	10 oz.
Albumen	200 ccm	3 1/3 oz.
Glycerine	100 ccm	768 min.

Mix well, and apply as usual to the paper.

The Iron Processes

FERROPRUSSIATE OR CYANOTYPE PROCESS.—This process is much used for the preparation of engineering and draughtsman's plans, giving white lines on a blue ground, that is to say, a blue image is formed by the action of light. The sensitive solutions can be made as follows:

A. Ferric ammonium citrate (red)	250 g	4 oz.
Water	1000 ccm	16 oz.

Filter.

B. Potassium ferricyanide	200 g	3 1/5 oz.
Water	1000 ccm	16 oz.

Filter. The ferricyanide must be in perfectly clear ruby-red crystals, free from any adherent yellow powder; it is advisable to allow a little more in weighing out, and place the crystals in a flask; pour in some distilled water, shake, pour off the water, and repeat this operation; then add the water for the solution, and heat until dissolved. Mix the two solutions in equal volumes and filter. Either float the paper on the solution for 3 minutes, or paint the solution on freely with a broad flat brush, and dry as quickly as possible, preferably by heat. A much more sensitive paper is obtained by using the green ammonio-citrate of iron; then the solutions should be:

A. Ferric ammonium citrate (green)	125 g	2 oz.
Water	500 ccm	8 oz.

Filter, and add:

B. Potassium ferricyanide	45 g	346 gr.
Water	500 ccm	8 oz.

Filter. The method of using is as above. Brighter prints are obtained by the addition of 0.5 per cent of oxalic acid to the above; the paper keeps better if 0.05 per cent of potassium bichromate is added.

The use of sodium or ammonium ferric oxalate gives greater speed than the above, but the paper does not keep so well. The sensitiser should then be:

Potassium ferricyanide	133 g	1021 gr.
Ferric ammonium citrate (red)	166 g	1277 gr.
Sodium or ammonium ferric oxalate	33 g	253 gr.
Water	1000 ccm	16 oz.

All these solutions are sensitive to light. Other iron salts may also be used, for instance:

A. Sodium or ammonium ferric

oxalate	250 g	4 oz.
Water	1000 ccm	16 oz.

B. Potassium ferricyanide

	250 g	4 oz.
Water	1000 ccm	16 oz.

Filter both solutions, mix, and again filter. Or the following may be used:

A. Tartaric acid

	180 g	1382 gr.
Ferric chloride, anhydrous	68 g	522 gr.
Ammonia	q. s.	q. s.
Water	1000 ccm	16 oz.

Dissolve the acid in three-fourths of the water, then add the iron, and, when dissolved, add sufficient ammonia to neutralise the acid, about 175 ccm (2½ oz.) being required; excess of ammonia must be avoided. Filter, and add to:

B. Potassium ferricyanide

	217 g	1666 gr.
Water	1000 ccm	16 oz.

Mix the two solutions. This gives greater sensitiveness, but the prepared papers do not keep so well as the others.

It is important that the paper base should be free from wood pulp, preferably sized with starch, and with a hard surface. It has been suggested to add white dextrine to the sensitiser, but this lowers the keeping quality. The paper should be exposed preferably to sunlight until the ground, corresponding to the whites of the negative or plan, appears a dark olive-green; it should then be thoroughly washed with running water, and the lines should appear white on a deep blue background. With stale paper or with excess of or impure ferricyanide, the lines will appear more or less tinted. With underprinting the colour is more or less pale. Frequently, by somewhat prolonging the washing, the lines will clear up; or this can be much curtailed by using a 0.01 per cent solution of ammonia or sodium carbonate. This gives a violet tinge to the blue, and this can be corrected by subsequent treatment with an acid, 5 per cent of hydrochloric, oxalic or sulphuric acid, or alum solution of the same strength. A much more stable and contrasty image is obtained if the print is developed with a 0.2 per cent solution of potassium ferricyanide, and well washed for four or five minutes.

Numerous methods have been suggested for toning blue prints, but, as a rule, the results are extremely unsatisfactory. Immerse the dry print in:

Ammonia (sp. gr. 897)	12.5 ccm	96 min.
Water	1000 ccm	16 oz.

As soon as the blue color disappears, wash for a few minutes, and then immerse in a 2 per cent solution of tannin; this gives a blackish colour, but the outlines may become blurred from spreading of the colour into the whites. Or the print may be well washed in distilled water, and bleached in yellow light in:

Silver nitrate	20 g	154 gr.
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Water	1000 ccm	16 oz.
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Wash with distilled water, and fume with ammonia, expose to light, and develop with ferrous oxalate; then wash thoroughly.

The cyanotype process may be used for making lantern slides or transparencies, though, naturally, the colour is suitable for but few subjects. The sensitising solution is rather weaker than used for paper:

A. Ferric ammonium citrate

(green)	250 g	4 oz.
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Water	1000 ccm	16 oz.
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B. Potassium ferricyanide

100 g	768 gr.
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Water	1000 ccm	16 oz.
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Mix in equal volumes and filter. Gelatinised glass (fixed out dry plates may be used) should be immersed for 5 minutes, and rapidly dried. The sensitiser will not keep when mixed. The plates should be exposed like the paper, and washed in the same way.

PELLET'S OR GUM-IRON PROCESS.—This process gives blue lines on a white ground, thus the reverse of the cyanotype process, from a drawing or plan. The paper has very poor keeping qualities. Originally patented by Pellet. Three stock solutions should be prepared (Pizzighelli):

A. Gum arabic

200 g	3 1/5 oz.
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Water	1000 ccm	16 oz.
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B. Ammonio-citrate of iron (red)

500 g	8 oz.
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Water	1000 ccm	16 oz.
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C. Ferric chloride

500 g	8 oz.
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Water	1000 ccm	16 oz.
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These solutions will keep indefinitely in the dark, with the exception of A, which becomes acid in about a week. For use mix in the following order:

A solution	200 parts
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B solution	80 parts
C solution	50 parts

It is important to adhere to this order, for, if A be added to C, the mixture becomes lumpy and useless. The mixture is at first thin and fluid, but soon becomes more viscous, and in a few hours cloudy and of the consistence of soft butter. It should be used in this condition and will keep in the dark for several days. Haugk recommended:

Gum arabic solution, 1:5	300 to 350 parts
Ammonium ferric oxalate solution, 6:10	100 parts
Ferric chloride solution, 1:2	20 to 30 parts

Float the paper on this mixture. Another excellent formula (Waterhouse) is:

A. Gum arabic	170 g	6 oz.
Water	650 ccm	22 oz.
B. Tartaric acid	40 g	617 gr.
Water	150 ccm	5 oz.

C. Ferric chloride solution,
sp. gr. 1.453 100 to 120 g 1543 to 1851 gr.

Filter the gum solution through a sponge or pad of cotton, and mix with the acid; then add the iron solution, which should be weighed, not measured, with constant stirring. Allow the mixture to stand in the dark for 24 hours, and add water to make the specific gravity 1.100. Well-sized paper, preferably gelatine-sized, should be fastened by pins to a flat board, and the mixture applied not too thickly with a flat brush. As soon as the brush begins to drag, the coating should be evened out with a round brush with circular strokes. This operation should be performed by artificial light, and the paper rapidly dried in the dark. The paper should be kept under pressure. The exposure will be from 15 to 40 seconds in the sun, or proportionately longer in diffused

light under a drawing; the image is seen in a bright yellow colour on a darker ground.

Development is effected with a 20 per cent solution of potassium ferrocyanide; the paper may be pinned to a board, and a very soft brush, charged with the solution, passed over the surface, care being taken not to rub up the image. Or the edges of the paper may be turned back to the height of about an inch and the print floated, face down, on the solution. The edges are turned up to prevent any solution touching the back of the print, which would cause blue stains. In about half an hour, if the print is floated, a corner may be turned back and the image examined; if it is fully visible, the print should be washed with a spray or in running water for a short time, immersed in a 1 per cent solution of hydrochloric or sulphuric acid, the surface gently rubbed with a soft brush to remove the slight blue deposit, then again washed in water, again brushed, and hung up to dry. Corrections can be made with solution of potassium oxalate, about 15 per cent, thickened if necessary with gum arabic.

FERROGALLIC OR INK PROCESS.—This is also sometimes known as Colas's process. It gives black lines on a white ground. The sensitiser is a mixture of ferric chloride or sulphate, and tartaric acid, thickened with gum, or gelatine:

Ferric chloride	50 g	1 oz.
Ferric sulphate, basic	25 g	½ oz.
Tartaric acid	45 g	432 gr.
Water	500 ccm	10 oz.

Dissolve, and add:

Gelatine	25 g	½ oz.
Water	250 ccm	5 oz.

Soak the gelatine in the water for 30 minutes and melt with

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heat. Filter the mixture through fine linen. Or the following may be used:

Gum arabic	100 g	768 gr.
Ferric chloride	328 g	2519 gr.
Tartaric acid	220 g	1690 gr.
Ferric sulphate, basic	220 g	1690 gr.
Water	1000 ccm	16 oz.

Dissolve in the above order and filter. The following (Fisch) is only suitable for heavily sized or gelatinised papers:

Ferric chloride	100 g	768 gr.
Water	500 ccm	8 oz.

Dissolve, and add:

Tartaric acid	30 g	230 gr.
Water	500 ccm	8 oz.

Or the following (Shawcross) may be used for any paper:

Gelatine	137 g	1052 gr.
Ferric sulphate, basic	55 g	422 gr.
Sodium chloride	87 g	668 gr.
Tartaric acid	17 g	130 gr.
Ferric chloride	137 g	1052 gr.
Water	1000 ccm	16 oz.

The solutions should be applied with a broad flat brush or pad by artificial light, and rapidly dried. The paper will keep for 2 or 3 weeks. Exposure should be made under a drawing for about 10 minutes in sunlight, or until the lines appear yellow on a white ground. Development is effected on:

Gallic acid	6 g	46 gr.
Oxalic acid	1 g	7.7 gr.
Water	1000 ccm	16 oz.

Or:

Gallic acid	12.5 g	96 gr.
Alum	12.5 g	96 gr.
Water	1000 ccm	16 oz.

The image should become black in from 3 to 5 minutes. The print may be completely immersed in the developer or floated on its surface. As soon as the image is intense enough, wash with repeated changes of water, gently blot off the surface water, and hang up to dry in a warm place. It should be noted that the ferric sulphate used in this process is the basic variety, also known as subsulphate, or Monsell's salt.

GREASY OR PRINTER'S INK PROCESS.—In this process the solubilisation of a colloid by the action of light on the iron salts, and the capacity of the insoluble colloids for taking greasy ink is employed; it was suggested by Fisch:

Gum arabic	320 g	2451 gr.
Water	1000 ccm	16 oz.

Dissolve, and add:

Tartaric acid	70 g	540 gr.
Water	250 ccm	4 oz.

And add, with constant stirring:

Ferric chloride solution, 45° Be.	225 g	3 oz., 288 gr.
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Then add:

Manganese sulphate	10 g	77 gr.
Water	25 ccm	192 min.

Allow to stand in the dark for several hours, and then filter through fine muslin. Coat the paper in the usual way, and dry at 35° to 45° C. (95° to 113° F.). Or the following may be used:

Gum arabic	325 g	2496 gr.
Water	1000 ccm	16 oz.

Dissolve, and add:

Tartaric acid	75 g	576 gr.
or Citric acid	300 g	4 4/5 oz.

Then add, with constant stirring:

Ferric sulphate	26 g	200 gr.
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or Ferric nitrate	400 g	6½ oz.
And add in the same way:		
Uranium nitrate	6 g	46 gr.
or Uranium chloride	200 g	3¼ oz.

Finally, add:

Ferric chloride solution,		
sp. gr. 1.453	210 ccm	3½ oz.

Filter through muslin and coat well-sized paper therewith. The exposure will be from 3 to 6 minutes in sunlight. Place the print face up on a sheet of zinc or glass, and with a roller lightly charged with printer's ink roll up the surface until uniformly grey. Immerse the inked print in cold water, transfer to a metal or glass plate supported at an angle, and allow a spray or stream of water to play over the surface; with a pad of absorbent cotton gently rub the print. The exposed parts will be gradually dissolved, leaving only the inked parts.

TRUE-TO-SCALE PROCESS.—A cheap and ready process for obtaining a few, about 25, pulls in printer's ink from line drawings, etc. A good black original is the best. Ferroprussiate or cyanotype paper should be exposed under the plan or drawing, and without development laid down on a "graph" or jelly, gently rubbed into contact, and immediately stripped. The jelly is now rolled over with a good letterpress ink with a composition roller and it only takes on the lines. A piece of paper is now laid on the jelly and rolled over lightly with a light roller, and, on lifting, the impression will be found on the paper. Inking must be done before each pull. The jelly can be made as follows:

Glue	500 g	8 oz.
Water to make	1000 ccm	16 oz.
Allow to soak for some hours, melt with heat, and add:		
Gelatine	62.5 g	1 oz.

Water to	125 ccm	2 oz.
Soak, melt by heat, and add :		
Ferrous sulphate	33.3 g	$\frac{1}{2}$ oz.
Glycerine	33.3 ccm	$\frac{1}{2}$ oz.
Strain, and cast into flat tins. Or the following may be used :		
Gelatine	450 g	1 lb.
Water	2550 ccm	90 oz.
Size powder	450 g	1 lb.
Iron alum	42 g	$1\frac{1}{2}$ oz.
Water	570 ccm	20 oz.

Dissolve the gelatine in the water ; then add the size powder. Dissolve the alum in the water, and add to the gelatine-glue solution gradually, stirring all the time. Pour into tins or on a slab. After use it can be remelted and used again, but a little fresh jelly should always be added. Or the following (Albert) :

Gelatine	160 g	1228 gr.
Glycerine	15 ccm	115 min.
Ox-gall	25 g	192 gr.
Ferrous sulphate	2 g	15.4 gr.
Water to	1000 ccm	16 oz.

Soak the gelatine in water, melt, add the other ingredients, and, finally, the iron salt dissolved in a little water. Cast on zinc which has been roughened with emery to cause it to adhere well. The coating should be 2 mm ($\frac{1}{25}$ in.) thick.

PLAYERTYPE.—This is a method of copying printed matter invented by J. H. Player, in which a sheet of sensitive paper, bromide or development (gaslight), is placed face down on the printed matter, pressed into contact and exposed through the back. On development a negative copy is obtained. The slower papers are more suitable ; the paper should be pressed into contact by a sheet of plate glass, and the latter covered with a yellow filter which can be made by immersing fixed out

dry plates in a 2 per cent solution of tartrazin. The exposure varies from 30 seconds to 2 minutes, according to the sensitiveness of the paper and the strength of the light. The developer should be preferably hydrochinon well restrained with bromide, as generally used for line work. Printing-out paper may be used in the same way. And also the following (Albert) :

Albumen	60 ccm	460 min.
Fish glue, Le Page's	40 ccm	307 min.
Ammonium bichromate	45 g	346 gr.
Water	1000 ccm	16 oz.

Or:

Fish glue	37.5 ccm	288 min.
Ammonium bichromate	3 g	23 gr.
Grape sugar	3.25 g	25 gr.
Water	1000 ccm	16 oz.

Dissolve the sugar in about one-fourth of the water before adding the other ingredients. Glass should be coated with a whirler and exposure is best effected with a half-watt lamp at a constant distance, the glass being placed with the coated side down on the drawing. Development is effected with hot water, and the print can then be stained up with a solution of a dye, such as chrysoidin, water soluble nigrosin, or by immersion in a 4 per cent solution of potassium permanganate, which gives a deep brown image of manganese dioxide.

COBALT-IRON PRINTING (*Burian*).—This process seems more suitable for line drawings than prints from ordinary photographic negatives.

Oxalic acid	8 g	61.5 gr.
Water	30 ccm	230 min.

Heat until dissolved, and add:

Ammonium oxalate, neutral	24 g	184 gr.
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When dissolved, add:

Cobalt carbonate	8 g	61.5 gr.
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Effervescence takes place, and the mixture should be digested until it turns red. The cobalt carbonate can be made by adding 39 g (299.5 gr.) crystallised sodium carbonate to 16 g (123 gr.) of crystallised cobalt chloride, and washing and drying the precipitate. To the above red liquid, cooled down to 35° C. (95° F.), add:

Lead peroxide	5 g	38.5 gr.
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Glacial acetic acid	3 ccm	23 min.
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On shaking, the solution turns a deep green. From this point all further operations must be conducted by yellow light. Add:

Lead peroxide	5 g	38.5 gr.
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Glacial acetic acid	3 ccm	23 min.
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Pour the solution out into a flat dish, and allow to evaporate until crystals form and it is dry. Add 10 ccm (77 min.) of water, filter, and make the bulk up to 1000 ccm (16 oz.). The iron salt is obtained by mixing 20 g (154 gr.) of ferric sulphate with ammonia, washing the precipitate, and adding 36 g (276.5 gr.) of acid ammonium oxalate. This can be made by adding 30 ccm (230 min.) of ammonia to 100 g (768 gr.) of oxalic acid, gently heating, adding more ammonia until the solution smells distinctly of ammonia, then heating to drive off excess of ammonia, adding 100 g (768 gr.) of oxalic acid, heating until dissolved, and allowing to crystallise. The actual sensitising solution is made by mixing 2 parts of the cobalt solution with 1 part of the iron. Paint on the paper with a brush and dry rapidly; the paper should be a green colour. Exposure may be to daylight or an arc, and the image should show a bright yellow on the green ground. Development is effected in a 1 per cent solution of potassium ferricyanide until the whites appear white; then briefly wash and immerse in 1 per cent hydrochloric

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acid; again wash and immerse in a 1:400 solution of sodium sulphide until the paper turns grey; then wash until white. The sensitised paper will only keep about 6 hours. If the ordinary ferric oxalate be used, the process is said to be suitable for ordinary negatives.

KALLITYPE.—This is a silver-iron printing process, based on the light-sensitiveness of ferric salts, which are reduced to the ferrous state. The ferrous salts dissolve in the developer, and reduce silver nitrate to the metallic state at the points where the ferric salt has been reduced by light.

Hall's Formulas.—

A. Ferric oxalate	200 g	1 oz.
Gum arabic	20 g	48 gr.
Water	1000 ccm	5 oz.
B. Ferric potassium oxalate	62.5 g	½ oz.
Water	1000 ccm	8 oz.
C. Oxalic acid	125 g	½ oz.
Ammonia	52 ccm	100 min.
Water	1000 ccm	4 oz.
D. Potassium bichromate	62.5 g	120 gr.
Water	1000 ccm	4 oz.

For use mix 480 parts A, 240 parts B, 30 parts C, and 4 parts D. Then add silver nitrate, dry, 37.5 parts. For thin and soft negatives, increase the proportion of D from 30 to 50 per cent, and reduce the proportion of C by one-half or more.

Developer:

Sodium acetate	125 g	1 oz.
Tartaric acid	3.125 g	12 gr.
Solution D, above	5 to 50 ccm	10 to 100 min.
Water	1000 ccm	8 oz.

Clearing bath:

Sodium citrate	31.25 g	¼ oz.
Citric acid	5 g	20 gr.

Water	1000 ccm	8 oz.
Wash the prints well and fix in:		
Hypo	50 g	1 oz.
Ammonia	12.5 ccm	120 min.
Water	1000 ccm	20 oz.

Thomson's formulas.—

Ferric oxalate	150 g	75 gr.
Ferric ammonio-citrate, brown	20 g	10 gr.
Cupric chloride	18 g	9 gr.
Gum arabic	20 g	10 gr.
Water	1000 ccm	1 oz.

Dissolve the ferric oxalate in warm water and allow to stand all night; then add the other ingredients, and filter. The solution will not be clear. Print until the deepest shadows are well visible. The developer is composed of equal parts of a 5.2 per cent solution of Rochelle salts and a 9.4 per cent solution of borax with the addition of 0.02 to 0.8 per cent potassium bichromate, which keeps the whites pure and acts as a restrainer. The prints should be left in the developer for 30 minutes, well rinsed, then fixed in:

Hypo	31.25 g	240 gr.
Ammonia	7.8 ccm	60 min.
Water	1000 ccm	16 oz.

Wash for 30 minutes.

Thomson's later formulas.—

1. Ferric ammonio-citrate, brown	20 g	10 gr.
Ferric oxalate	66 g	33 gr.
Potassium oxalate	74 g	37 gr.
Cupric chloride	12 g	6 gr.
Gum arabic	20 g	10 gr.
Potassium bichromate		
sol., 1:48	2 to 10 ccm	1 to 5 drops
Water	1000 ccm	1 oz.

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2. Ferric ammonio-citrate, brown	12 g	6 gr.
Ferric oxalate	60 g	30 gr.
Potassium oxalate	60 g	30 gr.
Cupric chloride	12 g	6 gr.
Gum arabic	20 g	10 gr.
Water	1000 ccm	1 oz.
3. Ferric ammonio-citrate, brown	50 g	25 gr.
Ferric oxalate	30 g	15 gr.
Potassium oxalate	70 g	35 gr.
Cupric chloride	16 g	8 gr.
Oxalic acid	30 g	15 gr.
Silver nitrate	30 g	15 gr.
Gum arabic	20 g	10 gr.
Water	1000 ccm	1 oz.

Add potassium bichromate solution, 1:48, as desired.

In preparing these solutions, mix in the above order, leave for 24 hours in the dark, and filter through cotton. Print faintly, and develop in:

Silver nitrate	80 g	40 gr.
Citric acid	20 g	10 gr.
Oxalic acid	16 g	8 gr.
Water	1000 ccm	1 oz.

Add sodium phosphate 3 g ($1\frac{1}{2}$ gr.) for blue-black tones.

For use mix 1 part with 7 parts water. Fix in:

Hypo	3 to 4 g	24 to 32 oz.
Water	1000 ccm	16 oz.

For brown, blue-green, and other colours:

A. Ferric ammonio-citrate, green	70 g	35 gr.
Ferric oxalate	16 g	8 gr.
Potassium oxalate	12 g	6 gr.
Oxalic acid	44 g	22 gr.
Uranium nitrate	40 g	20 gr.
Gum arabic	20 g	10 gr.

Water	1000 ccm	1 oz.
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Potassium bichromate		
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solution, 1:48	6 to 12 ccm	13 to 6 drops
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Allow to stand 24 hours in the dark; then filter.

B. Silver nitrate	100 g	50 gr.
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Citric acid	60 g	30 gr.
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Tartaric acid	20 g	10 gr.
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Water	1000 ccm	1 oz.
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First coat the paper with A, and allow to dry; then coat with

B. Print in the sun until the half tones are slightly tinted.

For sepia tones wash and fix in:

Salt	4 g	12 gr.
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Hypo	4 g	12 gr.
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Water	1000 ccm	6 oz.
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For green tones immerse the print in:

Potassium ferricyanide	3 g	4 gr.
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Nitric acid	3 ccm	4 drops
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Water	1000 ccm	4 oz.
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Remove from this solution just before the green tone is reached, and fix in weak hypo.

Platinotype

This process is based on the light-sensitiveness of ferric oxalate, which is reduced by the action of light to ferrous oxalate, which dissolves in the alkaline oxalate used as a developer, thus reducing the platinum salt, used in the sensitiser, in situ; the iron salts form no part of the image.

It is important that the ferric oxalate should be free from ferrous salt, and the most satisfactory way to ensure this is to prepare it. The following method should be adopted:

Ammonia iron alum	520 g	9 oz., 56 gr.
Water	500 ccm	8 oz.

Heat until dissolved, allow to cool slightly, and add:

Ammonia	200 ccm	3¼ oz.
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Stir well for about 5 minutes. Then filter the solution, and wash the filter with repeated lots of water until the filtrate is no longer alkaline to litmus paper. Then dissolve in:

Oxalic acid, pure	215 g	1651 gr.
Hot water	800 ccm	12 oz.

Pour this solution over the filter repeatedly until all the ferric hydroxide is dissolved; wash the filter with sufficient water to make the volume of the solution 1000 ccm (16 oz.). An alternative method, which obviates the necessity of filtering, but takes longer, is to powder some iron alum, and weigh out the above quantities. Place the powder in a tall graduate; the tall metric cylindrical graduates are the most convenient. Pour on the powder the above quantity of ammonia mixed with an equal volume of water. Stir for a few minutes, and allow to stand for 10 minutes. Fill up the graduate with water, shake or stir well, allow to stand until the precipitate has somewhat subsided, and syphon off the

supernatant liquid. Repeat these operations until the liquid no longer turns red litmus paper blue. Finally, allow the precipitate to settle, and syphon off the water until the total bulk measures no more than 850 ccm ($13\frac{1}{2}$ oz.). Add the oxalic acid dry, stir well for a few minutes until the solution clears up, then filter, and wash the filter with enough water to make the total bulk 1000 ccm (16 oz.). The result will be a 20 per cent solution of ferric oxalate with an excess of 1.2 per cent of oxalic acid. The addition of the oxalic acid and the subsequent filtration must be effected by artificial light, not daylight, and the solution must be kept in the dark. Dry ferric oxalate, as obtainable commercially, is rarely suitable.

Another stock solution required is a mixture of lead-iron oxalate. This is made as follows:

Lead acetate, pure	10 g	154 gr.
Water	100 ccm	3 oz., 183 min.

Dissolve by the aid of heat, and add:

Oxalic acid, pure	4 g	62 gr.
Water	50 ccm	1 oz., 330 min.

A white precipitate of lead oxalate is formed, which should be collected on a filter, well washed with water, and dried. Add 1 part of the dry precipitate to 100 parts of the normal ferric oxalate solution, as given above.

A stock solution of sodium ferric oxalate will also be required:

Sodium ferric oxalate	500 g	3840 gr.
Water	1000 ccm	16 oz.

Shake until dissolved and filter. A stock solution of oxalic-gelatine will be required, but this will not keep more than 3 or 4 days:

Gelatine	10 g	96 gr.
Water	100 ccm	2 oz.

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Allow to soak for 15 minutes, dissolve by heat, and add:

Oxalic acid, pure	2.5 g	24 gr.
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There will be further required a 10 per cent solution of sodium platinum chloride $(\text{NaCl})_2 \cdot \text{PtCl}_4 \cdot 6\text{H}_2\text{O}$, and a 1 in 6 solution of potassium chloroplatinite. All stock solutions must be kept in the dark.

The best results are obtained with pure linen papers; cheap wood-pulp papers will not give good results. While it is not absolutely essential with good papers, a preliminary sizing is desirable, and for this purpose gelatine, arrowroot, or tragacanth may be used. The disadvantage of gelatine is that it is very prone to form air bubbles, and arrowroot is preferable. To prepare the gelatine size, make a 2 per cent solution of gelatine in water, and add 1 per cent of alum. To make the arrowroot rub 20 g (154 gr.) into a thin cream with water, add to 1000 ccm (16 oz.) boiling water with constant stirring, and continue boiling for 5 minutes. Allow to cool, and remove the skin which forms on top. The gelatine size must be used warm.

To apply the size, the paper should be pinned to a drawing board, or other flat surface at the corners and the size applied with a broad flat brush in straight strokes, first across and then up and down the paper, until the surface is uniformly wet. Then a round soft brush, a perfectly clean shaving brush being excellent, should be worked all over the surface until it appears even and begins to lose its gloss. It may then be hung up to dry. For rough drawing papers the sheets should be immersed in the size for from 5 to 30 minutes, according to the thickness of the paper, and the roughness of the surface. The paper should be drawn over the edge of the dish, so as to wipe off as much solution as possible, and then hung up to dry with the end that leaves the dish last at the top.

THE COLD BATH PROCESS.—To sensitise the paper it should be fastened by glass-headed push pins to a flat surface, with a sheet of blotting paper underneath. As it is important that the sensitising solution should not come into contact with the pins, it is advisable to provide the latter with guards, which can easily be prepared by cutting small squares of cardboard, turning up the edges, and passing the pins through the middle. As the paper expands and crinkles on application of the liquid, the pins may be removed, and the paper restretched and again pinned down. The sensitiser is:

A. Potassium chloroplatinite sol.	3 ccm	50 min.
Lead-iron sol.	4.5 ccm	75 min.
Sodium chloroplatinate	7.5 drops	7.5 drops
Water	3 to 8 ccm	50 to 130 min.

Or:

B. Potassium chloroplatinite sol.	3 ccm	50 min.
Lead-iron sol.	4.5 ccm	75 min.
Oxalic-gelatine sol.	1 ccm	17 min.
Sodium chloroplatinate	7.5 drops	7.5 drops
Water	3 to 8 ccm	50 to 130 min.

Or:

C. Potassium chloroplatinite sol.	3 ccm	50 min.
Lead-iron sol.	3 ccm	50 min.
Sodium ferric oxalate sol.	2 ccm	33 min.
Sodium chloroplatinate	7.5 drops	7.5 drops
Water	3 to 8 ccm	50 to 130 min.

The quantity of water in each formula is dependent on the surface of the paper; smooth surfaces require less, rough ones the greater quantity. Increase of the water to 2 to 14 times that given above gives grey prints. The above quantity of sensitiser is sufficient for 3750 qcm (580 sq. in.) of paper. Increase of the sodium chloroplatinate gives increased contrasts, or an equal volume of a 10 per cent solution of

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potassium bichromate may be used instead. Omission of these naturally gives softer effects. Sensitiser A with arrow-root sizing tends to brownish-black tones, but with plain, not arrowroot-sized, drawing papers, black tones; with gelatine-sized papers blue-blacks are given. A and B give too hard prints with contrasty negatives; then C should be used, as this gives softer results.

After printing until the image is faintly visible in greyish-violet against the pure yellow unprinted parts, the print should be rapidly and evenly immersed in either of the following developers:

Neutral potassium oxalate	250 g	4 oz.
Water	1000 ccm	16 oz.

Or:

Neutral potassium oxalate	100 g	770 gr.
Potassium phosphate	50 g	384 gr.
Water	1000 ccm	16 oz.

It is preferable to take hold of both ends of the paper, immerse one end in the developer, face down, draw right through the solution and then turn face up. Development is comparatively slow and takes from 1 to 2 minutes; the dish should be gently rocked. As soon as sufficient depth is attained, immerse the print, without washing, in:

Hydrochloric acid	20 ccm	154 min.
Water	1000 ccm	16 oz.

face downwards. The dish should be rocked. After 5 minutes, remove the print to a second dish of water acidulated as above, and, after 15 minutes, remove to a third dish of half the above strength of acid. At the end of 15 minutes, place the print in running water for 30 minutes, then blot off between blotting papers, and dry. Dilution of the developer gives more brilliant prints; or the same result may be obtained by adding 2 to 5 per cent of a 1 per cent solution of

potassium bichromate; but, in this case, printing must be carried further than usual. In place of the bichromate, 0.5 to 1 per cent of ammonium persulphate may be used, which shortens the scale of gradation, and this is particularly useful in the case of over-printing or when thin flat negatives are used.

SEPIA PAPER, COLD BATH.—Brown or sepia tones are readily obtained by the addition of a mercury salt to the sensitiser, and the best is mercuric citrate, prepared as follows:

Yellow mercuric oxide	5 g	96 gr.
Citric acid	25 g	480 gr.
Water	100 ccm	4 oz.

Heat until dissolved, and filter. The actual sensitiser is:

Ferric oxalate sol.	8 ccm	130 min.
Potassium chloroplatinite sol.	4 ccm	65 min.
Mercuric citrate sol.	1 to 4 ccm	16 to 65 min.
Sodium chloroplatinate sol.	2 to 5 drops	2 to 5 drops

This should be applied as described above and to the same area of paper. The best developer is one of the following:

Neutral potassium oxalate	100 to 300 g	154 to 462 gr.
Water	1000 ccm	16 oz.

Or:

Potassium oxalate	70 to 300 g	538 to 2304 gr.
Potassium phosphate	30 g	230 gr.
Oxalic acid	10 g	77 gr.
Water	1000 ccm	16 oz.

The stronger the developer, the more rapid its action and the softer the print; the more mercury salt used, the weaker should be the developer; with contrasty negatives and with less mercury, the stronger should be the developer. Prints

should be developed for not less than 5 minutes. The acid baths should not be stronger than from 0.5 to 1 per cent; the acid treatment with the three baths should not last longer than 30 minutes in all. The smaller quantities of the mercury solution give the best colours. For this process the best results are obtained with paper sized with agar-agar, which may be prepared as follows:

Agar-agar	10 g	77 gr.
Water	1000 ccm	16 oz.

Soak for 24 hours with an occasional stir, then pour off the water, and add enough fresh water to make the total bulk to the above quantities. Heat until boiling, and allow to boil for 10 minutes; filter through a piece of well-washed linen, and allow to cool until a firm jelly is obtained. This jelly should be squeezed twice through coarse canvas, so as to divide it up into little nodules. A small quantity should be placed on the paper, worked all over with a fairly stiff brush, then equalised with circular strokes with a softer brush, and dried. The quantity used depends on the surface of the paper, but this should not be strongly glazed when dry.

THE HOT BATH PROCESSES.—In this process a hot developer is used and the sensitiser should be:

Ferric oxalate sol.	6 ccm	42 min.
Potassium chloroplatinite sol.	4 ccm	28 min.
Gelatine-oxalic sol.	1 ccm	7 min.

Greater contrasts in the prints may be obtained by the addition of 5 to 10 drops of sodium chloroplatinate solution or a 1 per cent solution of potassium bichromate. The same developers as used for the cold bath papers may be used at a temperature of 50° to 75° C. (122° to 167° F.). For sepia tones the sensitiser should be:

Ferric oxalate sol.	6 ccm	100 min.
Potassium chloroplatinite sol.	4 ccm	67 min.

Mercuric chloride,

5% sol. 0.2 to 1 ccm 3 to 17 min.

Sodium chloroplatinate 2 to 10 drops 2 to 10 drops

Water 2 to 4 ccm 33 to 67 min.

The quantity of water is as before regulated by the surface of the paper. The solution should be applied in the manner already described. The best developer for this paper is:

Potassium oxalate 100 g 770 gr.

Potassium phosphate 50 g 380 gr.

Citric acid 20 g 154 gr.

Potassium chloride 10 g 77 gr.

Water 1000 ccm 16 oz.

Use at a temperature of 70° C. (158° F.).

COLD BATH PAPER (*Lainer*).—

A. Ammonium ferric oxalate 50 g 1¾ oz.

Water 58 ccm 2 oz.

Oxalic acid, 10% sol. 8 ccm 150 min.

B. Potassium chloroplatinite 2 g 30 gr.

Water 10 ccm 150 min.

The sensitiser for 3352 qcm (520 sq. in.) should be:

A solution 4 ccm 68 min.

B solution 8 ccm 136 min.

Potassium bichromate, 4% sol. 8 ccm 136 min.

Immerse the exposed print for from 1 to 3 minutes in the developer, special salts being supplied for this, until fully developed; then clear in four acid baths of hydrochloric acid, 1:60, and wash for a short time in running water. For sepia prints the developer should be heated to 66° to 88° C. (150° to 190° F.), and the prints cleared in three acid baths of half the above strength. Development should be effected in a feeble white light. The addition of 2 to 4 drops of a 10 per cent solution of potassium bichromate to the developer increases the brilliancy of the prints.

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PALLADIOTYPE PAPER.—This paper gives a very visible printing image, and exposure should be carried on until all details are visible. Immerse the prints face up in:

Sodium citrate	232.5 g	10 oz.
Citric acid	23.25 g	1 oz.
Water	1000 ccm	43 oz.

For black prints the temperature should be kept between 7° and 16° C. (45° to 60° F.). For sepia paper use:

Sodium citrate	50 g	6 oz.
Citric acid	2.6 g	150 gr.
Water	1000 ccm	120 oz.

Heating the developer to 38° C. (100° F.), not beyond, gives warmer tones. Clearing bath for both papers:

Sodium citrate	232.5 g	10 oz.
Citric acid	93 g	4 oz.
Water	1000 ccm	43 oz.

For use mix 1 part with 7 parts water. Three baths should be used, with 10, 15, and 20 minutes in the first, second, and third baths respectively. For brilliant prints add from 4 to 6 drops of a 10 per cent solution of potassium bichromate to the developer. Wash the prints in running water for 10 or 15 minutes or in several changes of 10 minutes each.

SATISTA PAPER.—Print until a faint image appears, and develop in:

Potassium oxalate	200 g	8 oz.
Oxalic acid	5.2 g	100 gr.
Water	1000 ccm	40 oz.

Temperature about 21° C. (70° F.); for warmer tones heat to 38° C. (100° F.). Clear the prints in:

Sodium citrate	4 g	1½ oz.
Water	1000 ccm	75 oz.

Three baths are advisable of 5, 10, and 15 minutes respectively, followed by a short washing for 10 minutes, not

longer, in running water or several changes of water. Then fix in:

Hypo	125 g	6 oz.
Water	1000 ccm	48 oz.

for 15 minutes. Finally, wash in running water for 45 minutes or in about 12 changes of water. The water used for the clearing bath must be free from lime. To free water from lime, dissolve oxalic acid 0.5 g (15 gr.) in 75 oz. (1000 ccm). Allow to stand for some hours, and decant from the precipitate.

THE PLATINUM-IN-DEVELOPER PROCESS.—A variation of the platinotype process consists in using either no, or very little, platinum in the sensitiser, and adding it to the developer. For this arrowroot size gives the best results, and the paper should not be highly sized. The sensitising solution may be one of the following:

A. Lead-iron sol.	5 ccm	80 min.
Mercuric chloride, 5% sol.	0.2 ccm	3 min.
Water	3 to 6 ccm	48 to 92 min.
B. Lead-iron sol.	5 ccm	80 min.
Potassium chloroplatinite sol.	0.5 ccm	8 min.
Water	3 to 6 ccm	48 to 92 min.
C. Lead-iron sol.	5 ccm	80 min.
Potassium chloroplatinite sol.	0.3 ccm	5 min.
Sodium chloroplatinate sol.	0.4 ccm	6.5 min.
Water	3 to 6 ccm	48 to 92 min.
D. Lead-iron sol.	5 ccm	80 min.
Sodium chloroplatinate sol.	0.8 ccm	13 min.
Water	3 to 6 ccm	48 to 92 min.

A and B are suitable for normal negatives; C gives greater contrast; and D should be used for very soft negatives. The area of paper is as previously stated. It is preferable to

allow the paper to dry at normal temperatures. The developer should be:

Potassium oxalate	1 g	16 gr.
Potassium chloroplatinite	1 g	16 gr.
Potassium phosphate	0.5 g	8 gr.
Water	12 ccm	192 min.
Glycerine	6 ccm	96 min.

Place the print face up on a sheet of glass, and paint with the above, using a broad flat brush, and working as quickly as possible. For the above area of paper about 20 ccm (154 min.) of developer will be required.

For line work or black and white work, this process is very suitable, and the following sensitiser should be used:

Lead-iron sol.	7.5 ccm	120 min.
Potassium chloroplatinite sol.	0.375 ccm	6 min.
Neutral potassium chromate, 1% sol.	0.375 ccm	6 min.
Water	7.5 ccm	120 min.

The above quantity is sufficient for 5940 qcm (870 sq. in.).

The best developer for this work is:

Potassium chloroplatinite	12 ccm	84 min.
Glycerine	50 ccm	350 min.
Water	450 ccm	8 oz.

Thirty ccm (1 oz.) should be used for the above area. Actually, this process is as cheap as or cheaper than any silver printing process. The acid baths must be used with all papers as already described.

PLATINUM PRINT-OUT PAPER.—It is possible to prepare platinum paper that will print out in the printing frame, but it does not keep well, and the results are greatly dependent on the humidity of the paper at the time of printing. If too dry, only the shadows will appear; while if too damp, flat

foggy results are obtained. The stock solutions are: A, the normal potassium chloroplatinite solution; B, sodium ferric oxalate 50 g (4 oz.), water 100 ccm (8 oz.); C, gum arabic 50 g (4 oz.), water 100 ccm (8 oz.). The sensitiser is:

Potassium chloroplatinite sol.	4 ccm	65 min.
Sodium oxalate sol.	6 ccm	98 min.
Gum sol.	4 ccm	65 min.

Increased contrast may be obtained by the addition of sodium chloroplatinate or potassium bichromate solution as in the other processes. The paper must be dried quickly. Exposing the paper to steam after printing, if the image appears of sufficient depth only in the shadows, is of some assistance, but, at the best, it is not a satisfactory process.

SEPIA TONES BY DEVELOPMENT.—Ordinary hot bath paper may be developed to sepia by the use of the following developer (Hübl):

Potassium oxalate	100 g	768 gr.
Potassium phosphate	50 g	384 gr.
Citric acid	20 g	154 gr.
Potassium chloride	10 g	77 gr.
Mercuric chloride	10 g	77 gr.
Water	1000 ccm	16 oz.

Use at a temperature of 80° C. (176° F.). Or the following may be used:

Potassium oxalate	65 g	500 gr.
Potassium citrate	11 g	85 gr.
Citric acid	16 g	123 gr.
Mercuric chloride	6.75 g	52 gr.
Water	1000 ccm	16 oz.

Heat to 35° C. (95° F.). Or the following (Jacoby) may be used:

Potassium oxalate	250 g	4 oz.
Zinc oxalate	100 to 125 g	800 to 1000 gr.

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Water 1000 ccm 16 oz.
Heat to 21° to 28° C. (69° to 83° F.). The larger the quantity of zinc oxide the warmer the tone. Or:

Potassium oxalate	200 g	3¼ oz.
Acid ammonium phosphate	25 g	200 gr.
Cupric sulphate	1 g	8 gr.
Water	1000 ccm	16 oz.

The following complicated developer has also been recommended:

A. Potassium oxalate	250 g	4 oz.
Water	1000 ccm	16 oz.
B. Cupric chloride	32 g	125 gr.
Water	1000 ccm	8 oz.
C. Mercuric chloride	62.5 g	1 oz.
Water	1000 ccm	16 oz.
D. Lead acetate	16 g	32 gr.
Water	1000 ccm	4 oz.

Add 12 parts of A to 4 parts B, then 4 parts C to 1 part D, and heat until the precipitate first formed is redissolved. Use at a temperature of 80° C. (176° F.).

LOCAL DEVELOPMENT.—By thickening the developer with glycerine, it is possible to develop cold-bath prints locally, so as to obtain various effects. Paint a sheet of glass larger than the print with glycerine, thinly and evenly. Use four teacups or saucers; fill A with pure glycerine; B, with glycerine 10 parts, saturated solution of potassium oxalate 1 part; C, with glycerine 10 parts, saturated solution of potassium oxalate 5 parts; D, with saturated solution of potassium oxalate. Lay the print face up on the glycerined glass, and dab into contact with a pad of clean linen. Paint the whole of the print with the pure glycerine, using a long-handled soft brush, and allow to soak for 3 minutes. Saturate the brush with the B mixture and paint over the whole

print. Then charge the brush with C solution, and paint those parts which it is desired to bring out more than the rest. Finally, treat any desired part with D solution. The glycerine merely prevents any lines of demarcation showing. The subsequent acid bath treatment is as usual.

INTENSIFYING PLATINOTYPES.—Weak platinotype prints can be intensified, and, unless much under-printed, good results are obtained.

Silver intensification (Clarke).—This is extremely liable to give a coarse granular deposit, which makes it unsatisfactory on the whole:

Glacial acetic acid	150 to 160 drops	50 to 60 drops
Pyrogallol	2 g	15.5 gr.
Water	1000 ccm	16 oz.

Dissolve, and add:

Silver nitrate, 12% sol.	20 drops	8 drops
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It is advisable to flood the print, which must be quite free from iron salts and acid, with the pyro solution, then to pour off the solution; add the silver to it, again flood the print, and repeat until sufficient intensity is attained. Hydrochinon or metol may be used instead of the pyrogallol. The print should be well washed, and, finally, fixed in weak hypo.

Intensification with platinum (Vogel).—

Potassium oxalate developer	5 ccm	80 min.
Water	50 ccm	800 min.
Potassium chloroplatinite		
sol.	3 to 5 drops	3 to 5 drops

This also tends to give coarse grain, and the whites are very apt to be stained. Far better results are obtained by the following (Hübl):

A. Sodium formate, 10% sol.

B. Platinum perchloride, 2% sol.

For use add 5 parts A to 200 parts water, and then add 5

parts B. Intensification will be complete in about 15 minutes.

Intensifying with gold (Dollond).—The print should be placed face up on a sheet of glass, and, if previously dried, must be soaked in water first. Dab into flat contact with a clean linen pad, and paint the surface with glycerine, using a soft brush. Then pour on the surface a few drops of a 1.5 per cent solution of gold chloride and paint rapidly over with the brush. As soon as the desired intensity is reached, rinse under the tap, and sponge back and front with a normal metol developer diluted with an equal volume of water. There is some danger of the white assuming a pink or blueish tint with this process.

TONING PLATINOTYPES.—Platinum prints can be toned with uranium, iron, and catechu. The first gives brownish-red tones, the second blue, and the third browns. For the uranium toning the following stock solutions are required:

A. Uranium nitrate	100 g	768 gr.
Glacial acetic acid	100 ccm	768 min.
Water	1000 ccm	16 oz.
B. Potassium ferricyanide	100 ccm	768 gr.
Water	1000 ccm	16 oz.
C. Ammonium sulphocyanide	500 g	3840 gr.
Water	1000 ccm	16 oz.

For use add 10 ccm A to 1000 ccm water (77 min. to 16 oz.); then add 10 ccm (77 min.) C and, finally, 10 ccm (77 min.)

B. Instead of the sulphocyanide, 5 ccm (35 min.) of a 10 per cent solution of sodium sulphite may be used. The well-washed print should be placed in a dish, well flooded with plenty of the solution, and the dish rocked until the desired tone is obtained. On the slightest sign of the solution becoming cloudy, pour off and apply fresh; otherwise the whites will be stained.

The iron toning requires:

C. Ammonia iron alum	100 g	768 gr.
Hydrochloric acid	100 ccm	768 min.
Water	1000 ccm	16 oz.

For use add 5 ccm (35 min.) A to 1000 ccm (16 oz.) water, then 2 ccm (14 min.) B, and, finally, 5 ccm (35 min.) C. Both these baths, particularly the uranium, intensify the prints.

The catechu toning process (Packham) gives warm brown tones, but it is difficult to keep the whites pure; on the other hand, this is rather effective than otherwise, as the print appears as if prepared on toned paper. A stock solution is prepared of:

Catechu	78 g	600 gr.
Water	1000 ccm	16 oz.

Boil for 5 minutes in a glass or porcelain vessel, and add:

Alcohol	200 ccm	3 1/5 oz.
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For use mix:

Stock solution	2.5 ccm	20 min.
Water	1000 ccm	16 oz.

When used cold, this takes some hours to tone, but, by raising the temperature to 55° to 64° C. (130° to 147° F.), only about 15 minutes is necessary. Should the whites be stained, and it is desired to remove this, soak in:

Castile soap	9 g	69 gr.
Sodium carbonate, cryst.	18 g	138 gr.
Water	1000 ccm	16 oz.

When the stain is reduced, wash and dry.

COPPER TONING (*Menke*).—Four stock solutions are required:

A. Cupric sulphate	41 g	38.5 gr.
Water	1000 ccm	16 oz.
B. Potassium ferricyanide	35.7 g	274 gr.
Water	1000 ccm	16 oz.

C. Potassium citrate, sat. sol.

D. Potassium sulphocyanide	100 g	768 gr.
Water	1000 ccm	16 oz.

For use mix in the following order: A 140 parts, B 140 parts, C 24 parts, D 50 parts. As this is nothing more than a modification of the copper toning process for bromides, presumably the same class of tones will be obtained.

BLUE PRINTS BY DEVELOPMENT (*Waverley*).—

Potassium oxalate, 1:3 sol.	22 ccm	170 min.
Potassium ferricyanide,		
10% sol.	9 ccm	70 min.
Glycerine	55 ccm	42 min.
Water	1000 ccm	16 oz.

Printing must be carried deeper than usual. The prints assume a green tone in the developer and only turn blue in the acid baths.

PRINT-OUT SEPIA PAPER.—Another method of obtaining pure brown tones is by the admixture of some palladium salt with the sensitiser, potassium chloropalladite in 10 per cent solution being used. The paper should preferably be sized with arrowroot, and the sensitiser is:

Potassium chloropalladite sol.	4 ccm	65 min.
Sodium ferric oxalate	6 ccm	97 min.
Lead-iron sol.	2 ccm	32 min.
Water	3 to 6 ccm	45 to 96 min.

The image is so slightly visible that an actinometer should be used. Development should be effected with steam or by pressing the prints between damp blotting papers.

Another method is by the use of mercury (*Pizzighelli*):

A. Potassium chloroplatinite	10 g	70 gr.
Water	60 ccm	420 min.
B. Sodium ferric oxalate	40 g	280 gr.
Gum arabic	40 g	280 gr.

Sodium oxalate, 3% sol.	100 ccm	700 min.
Glycerine	3 ccm	21 min.
Potassium chlorate	0.5 g	3.5 gr.

Heat the sodium oxalate solution to 40° to 50° C. (104° to 122° F.), add the iron salt, the chlorate, and the glycerine; pour on to the gum, rub until dissolved, and strain through linen. The chlorate can with advantage be replaced by about 10 to 20 drops of 1 per cent solution of potassium chromate.

C. Mercuric chloride, 5% sol.	20 ccm	140 min.
Sodium oxalate, 3% sol.	40 ccm	280 min.
Gum arabic	20 ccm	140 min.
Glycerine	1.8 ccm	12.5 min.

This is prepared in the same way as B. For sensitising 2000 qcm (310 sq. in.) use:

Solution A	5 ccm	35 min.
Solution B	4 ccm	28 min.
Solution C	4 ccm	28 min.

The following may also be used (Watzek):

Sodium ferric oxalate	10 ccm	160 min.
Potassium chloroplatinite	6 ccm	92 min.
Mercuric chloride	5 drops	5 drops

Add a few drops of 1 per cent solution of potassium bichromate to obtain contrasts. The other salts should be saturated solutions at 18° C. (64° F.). The paper should be sized with starch or arrowroot, two to three coats being used. Printing is continued until the desired depth is reached.

RESTORING PLATINOTYPES.—Sometimes through insufficient washing the paper of platinotypes yellows with age, due to the action of the air on the residue of iron salts. This stain can be removed by treatment with a weak solution of chloride of lime or eau de Javelle. Make a saturated solution of chloride of lime in water, filter, and add 1 part of the clear solution to 100 parts of water, then add dilute hydro-

chloric acid until there is a faint smell of chlorine. Or mix 1 part of chloride of lime with 1 part of sodium carbonate and 10 parts water, stir well, filter or decant the clear solution, add 90 parts water, and faintly acidulate as above. Immerse the stained print in either of these solutions until bleached; then wash and dry. This treatment cannot affect the image.

VARNISHING PLATINUM PRINTS.—Frequently platino-types appear rather dull and sunken-in compared to their appearance when wet. Application of print varnishes will then brighten them up; but the surface should not appear glossy. Artist's size, diluted with warm water, may be used; or megilp may be used in the same way; or the print may be sprayed or lightly painted with 1 part of mastic varnish diluted with 8 parts alcohol. For stronger effects ordinary negative varnish may be applied locally or generally with a brush. Or a solution of gelatine, about 4 per cent, may be made, the print bodily immersed in this while warm, and hung up to dry. Or the print may be rubbed with encaustic paste.

PLATINUM RESIDUES.—The high cost of platinum makes it well worth while to save all platinum residues. Scraps of paper, if unexposed, should be exposed to daylight and developed in the usual way. Print trimmings should be burnt, the scraps of the paper previously dealt with being mixed with them. The developer should be mixed with one-fourth its volume of saturated solution of ferrous sulphate, boiled, and the platinum precipitate allowed to settle or be filtered out. The first and second acid baths should also be saved, boiled down until of convenient bulk, at least one-fourth their original volume, and scrap zinc added. Black platinum is precipitated, and may be collected on a filter. It is not worth while to make the residues into platinum salts,

but the residues should be sent to a refiner, who will allow cash for them, with the deduction of a small fee for refining. An alternative plan is to mix the developing and acid baths, and immerse sheets of clean copper therein, when the platinum will be deposited on the copper as a precipitate. The platinum deposited on the copper can be scraped off, and mixed with the precipitated metal.

PLATINO-URANOTYPE.—A little-used process (Reynolds). Two stock solutions are required:

A. Uranium chloride, sat. sol.

B. Potassium chloroplatinite 4 g 60 gr.

Water 48 ccm 1½ oz.

Mix in equal volumes, paint over well-sized paper, and rapidly dry. Potassium chlorate may be added to increase contrast. Print until only a faint trace of an image is visible, and develop on a ferrous oxalate developer. Wash the prints in three successive baths of hydrochloric acid, about 1½ per cent, wash, and dry.

MERCURO-URANOTYPE.—Very little used (Reynolds). Two stock solutions are required:

A. Saturated solution of uranium chloride

B. Saturated solution of mercuric chloride

For use mix 8 parts A with 1 part B and apply to paper. Expose until the image is seen in full strength, then float on a dilute solution of chloride of gold or potassium chloroplatinite. Wash in water acidified with hydrochloric acid, wash and dry. The toning may be omitted when warmer tones are obtained.

PALLADIOTYPE.—Coat paper with uranium chloride, ferric oxalate, or sodium ferric oxalate, or a mixture of all three. Expose until the image is faintly visible; then float the print on:

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Potassium chloropalladite	1 g	1 gr.
Water	500 ccm	1 oz.

Or paint this over the print, wash in acidulated water, then in water, and dry. The image is somewhat similar to platino-type, but of a warmer colour.

TO DISTINGUISH A BROMIDE FROM A PLATINUM PRINT.—Touch a small corner of the print with a saturated solution of mercuric chloride, or a 10 per cent solution of potassium cyanide. In the first case, the bromide image is bleached, and, in the second, the bromide image is dissolved; platinum images are unaffected.

Ozotype and Allied Processes

OZOTYPE PROCESS.—This process is based on the transfer of the hardening effect of a chromate salt formed by exposure to light in the presence of a colloid, to another film containing a pigment.

A well-sized paper should be chosen, or be sized with a 2 per cent solution of gelatine. With rough or absorbent papers it may be necessary to give two or three coats, allowing to dry after each. Or the following may be used:

Soluble starch	100 g	768 gr.
Water	200 ccm	4 oz.

Rub into a cream, and add to:

Boiling water	800 ccm	12 oz.
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Allow to boil for 5 minutes, then filter through thick linen, and add:

Formaldehyde	50 ccm	25 min.
Alum	0.5 g	3.8 gr.

An almost clear solution that keeps well should result. Pin the paper to a board, and with a pad or flat brush paint the surface until it appears uniformly wet. Papers with very smooth surfaces may be floated on the above, diluted with an equal volume of water, or a 10 per cent solution of fish glue may be used in the same way. The paper must be thoroughly dried. The sensitising solution may be (Manly):

Potassium bichromate	50 g	384 gr.
Manganese sulphate	50 g	384 gr.
Water	1000 ccm	16 oz.

Or (Hübl):

Potassium bichromate	60 g	460 gr.
Manganese sulphate	30 g	230 gr.

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Alum	20 g	154 gr.
Boric acid	30 g	230 gr.
Water	1000 ccm	16 oz.

It is as well to add to this a few drops of fish glue. A piece of linen or Canton flannel should be wrapped round a reasonably large pad of absorbent cotton, some of the above solution poured on to the middle of the paper, evenly distributed with the pad, and then the paper hung up to dry in the dark. The exposure will be from 3 to 5 minutes in summer, and from 15 to 25 minutes in winter. The paper should then be washed in water, but too long washing must be avoided.

A piece of pigment tissue, the same size as the paper, should be immersed in the following:

Hydrochloric acid	2 ccm	15 min.
Ferrous sulphate	3.5 g	27 gr.
Water	1000 ccm	16 oz.

This is suitable for normal pictures; for contrasty prints reduce the iron salt to 2.5 g (19 gr.); and for soft prints increase to 4.5 g (35 gr.). When the tissue is quite limp, immerse the print in the bath, bring the two surfaces into contact, lift out together, squeegee into close contact, and leave for from 30 to 60 minutes, the longer time giving greater detail in the prints. Development may be effected at once, or delayed for some hours if more convenient.

A later procedure required the following stock solutions:

A. Hydrochloric acid	28 ccm	1 oz.
Cupric sulphate	31 ccm	480 gr.
Water	560 ccm	20 oz.

The working solution was composed of:

Hydrochinon	0.6 g	9 gr.
Water	1130 ccm	40 oz.
Solution A	14 to 28 ccm	½ to 1 oz.

For soft pictures of small size from hard negatives, use the

lesser quantity of A; for normal negatives use 21 ccm ($\frac{3}{4}$ oz.); and for large prints from soft negatives use the full quantity of A. The pigment tissue should be immersed in the above for 30 seconds, the print also immersed therein and brought into contact face to face, lifted out, thoroughly squeegeed, and left in contact as advised for the first bath. If the two are left in contact for more than $1\frac{1}{2}$ hours, they should be afterwards immersed in cold water for from 30 to 45 minutes. Development may be effected as in the carbon process with water from 43° to 46° C. (109° to 115° F.). As soon as development is complete, the print should be immersed in a 5 per cent solution of alum or:

Alum	28 g	1 oz.
Hydrochloric acid	1.7 ccm	30 min.
Hydrochinon	0.6 g	10 gr.
Water	560 ccm	20 oz.

for the same time, and then washed.

OZOBROME.—In this process, pigmented tissue impregnated with a bichromate and ferricyanide is brought into contact with a bromide print. The metallic silver reduces these compounds, and the gelatine is hardened in contact with the silver, so that it becomes insoluble in hot water, just as though it had been exposed to light. Practically, it is a carbon process, in which chemical action does the work of light; it is, therefore, possible to carry out the process at night, and many carbon prints may be obtained from one bromide, if thought desirable.

Any good bromide print may be used; but the best results are obtained with those not on baryta-coated paper. The print should be first hardened by immersion for 5 to 10 minutes in a 5 per cent solution of alum, or formaldehyde, or a 4 per cent chrome alum solution, washed, and dried. The ozobrome or sensitising solution is as follows (Manly):

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Potassium bichromate	6 g	46 gr.
Potassium ferricyanide	6 g	46 gr.
Potassium bromide	6 g	46 gr.
Alum	3 g	23 gr.
Citric acid	1 g	7 gr.
Water	1000 ccm	16 oz.

Or (Schmidt) :

Potassium bichromate	8 g	61 gr.
Potassium ferricyanide	10 g	77 gr.
Potassium bromide	7 g	54 gr.
Alum	1 g	7.7 gr.
Citric acid	0.5 g	3.8 gr.
Water	1000 ccm	16 oz.

Or (Faworski) :

Potassium bichromate	8.3 g	64 gr.
Potassium ferricyanide	6.6 g	51 gr.
Potassium bromide	6.6 g	51 gr.
Chrome alum	3 g	23 gr.
Citric acid	1 g	7.7 gr.
Water	1000 ccm	16 oz.

In hot weather the addition of 1 per cent of magnesium sulphate to the above baths is advantageous; or of (Namias) :

Chromic acid	5 g	38.5 gr.
Potassium bromide	20 g	154 gr.
Water	1000 ccm	16 oz.

The bromide print should be immersed in cold water for 10 minutes, and placed face up on a sheet of glass. The pigment tissue should be soaked in 1 part of the ozobrome solution diluted with from 4 to 5 parts of water for 2 to 3 minutes, and then transferred to an acid bath. This is preferably kept as a stock solution :

Chrome alum	100 g	768 gr.
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Oxalic acid	20 g	154 gr.
Water	1000 ccm	16 oz.

For use mix 150 parts with 850 parts of water, and add 1.2 parts citric acid. This last addition is not essential, but it keeps the whites cleaner. In this acid bath the tissue should be allowed to remain not longer than 7 to 15 seconds, then drawn once or twice over the surface of clean water, and squeegeed into contact with the wet bromide print. The two should be left under light pressure for about 15 minutes, and can then be developed like an ordinary carbon print with water at 40° to 45° C. (104° to 113° F.). Then the print should be fixed in hypo and ferricyanide to remove the silver, washed, and dried. In this case, the bromide print forms the basis of the carbon print. In the alternative or transfer process, the bromide print is stripped from the pigment tissue, the latter squeegeed into contact with transfer paper, and developed as usual. The procedure is precisely the same up to the point of development. At this point, the print and the adherent tissue are immersed in water for 1 minute, the print pulled off, and immersed in a dish of water. The carbon tissue is squeegeed into contact with transfer paper, which has been soaked in water for about 15 minutes, and then treated as in the carbon process. The bromide print should be well washed for 30 minutes, then immersed in daylight in an ordinary developer until fully developed, then washed, and dried. It can be repeatedly used in this way. It is obvious that enlargements may be treated in this way.

CARBRO PROCESS.—This is practically the ozobrome process. Two stock solutions are required:

A. Potassium bichromate	50 g	1 oz.
Potassium ferricyanide	50 g	1 oz.
Potassium bromide	50 g	1 oz.
Water	1000 ccm	20 oz.

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B. Glacial acetic acid	50 ccm	1 oz.
Hydrochloric acid, pure	50 ccm	1 oz.
Formaldehyde	1100 ccm	22 oz.

The working solutions are:

First bath.	A solution	1 part
	Water	3 parts
Second bath.	B solution	1 part
	Water	32 parts

The first bath may be repeatedly used, but the second should be made fresh every time. The temperature is important, and 18° C. (65° F.) is convenient. The bromide print must be thoroughly and evenly soaked in water. The tissue should be immersed in the first bath for 3 minutes, and transferred to the second bath. The length of stay in this determines the character of the resultant print. If the final print is to be like the bromide, 20 seconds would be correct; a shorter time gives increased contrasts, a longer time softer prints. The actual time varies with different makes of bromide paper, but the above rules apply to all. The soaked tissue is removed from the second bath, squeegeed into contact with the wet bromide print, and the two left in contact for about 15 minutes. A longer time gives a darker print. The tissue, after the lapse of the necessary time, is stripped from the bromide print, and the latter put into a dish of water to wash. The tissue should be brought into contact with a well-soaked sheet of transfer paper, thoroughly squeegeed, allowed to remain 30 minutes, and then developed as in the carbon process. A lower temperature of the developing water should be started with; hotter may be used as development proceeds, if necessary. Almost any kind of bromide paper may be used; but development (gaslight) papers are less satisfactory. After the bromide print has been well washed, it can be developed in white light with any developer. It is advisable for the

bromide print to have a white margin. Critical sharpness of the carbro print is not attainable, as the chemical action is a diffusion process, and this takes place sideways as well as downwards.

Oil and Bromoil

BROMOIL.—The most suitable bromide papers for this process are those with fairly thick emulsion films, with smooth or half matt surfaces which have not been hardened in the manufacture. Many firms make special papers for this work. A method of testing paper is to cut a strip, fix, wash, and dry as usual; then immerse in water at 25° C. (77° F.), gradually raise the temperature, and note when the film begins to feel slimy or slippery. This should be between 30° and 35° C. (86° and 95° F.); if higher than this, the gelatine has been hardened during manufacture, and is unsuitable for the purpose, or will require higher temperatures for the solutions than the usual ones, which range from 24° to 28° C. (75° to 82° F.). Any developer can be used, though the least suitable is pyrogallol, and the best temperature for development is 18° C. (65° F.). The prints should be well exposed and development carried to the limit, that is to say, until there is no longer any further accretion of density. The print should be rinsed two or three times with water and preferably fixed in a 30 per cent solution of hypo, containing 3 per cent potassium metabisulphite. Alum or chrome alum hypo baths are unsuitable. Washing should be carried out as usual. Some adherents of this process insist on the absolute necessity of drying the prints, while others consider it detrimental. The necessity, or otherwise, of this step depends on the character of the gelatine; soft gelatines require drying, while harder ones can be worked up at once.

As will be seen from the following tables, there is a wide choice of bleaching and relief-forming baths. Those containing copper salts are the most favoured. The most convenient

way of making these bleachers is to keep the ingredients in separate 10 per cent stock solutions, and mix as required. The best results are obtained with freshly made prints. Old prints should be soaked in water at 20° to 25° C. (68° to 77° F.) until quite limp, or the bleaching bath should be raised to these temperatures. Fresh solution should be used; repeated use of the same solution leads to irregularities.

Bleaching may take from 5 to 30 minutes, according to temperature and composition of the bath. With those baths containing potassium ferricyanide, a subsequent treatment with 5 per cent sulphuric acid is advisable. After bleaching the print should be washed and fixed in a 10 per cent hypo solution containing 2½ per cent sulphite, or 15 per cent hypo with 1½ per cent metabisulphite. If there is any sign of a coloured residue in the image, especially in the shadows, it may be removed by treatment with 2½ per cent sulphuric acid, and the print washed, or the following may be used:

Thiocarbamide	25 g	192 gr.
Ammonium persulphate	25 g	192 gr.
Water	1000 ccm	16 oz.

The prints should be washed for about ten minutes, then laid face up on a sheet of glass, the surface gently dabbed with a soft linen pad to remove any surface moisture, and should then be dried.

BLEACHING BATHS.—

	1	2	3	4	5	6	7	8
Potassium bichromate	22.5	18.2	10	8	10.3	8	10	29.5
Potassium bromide	11.25	10.0	..	7	10.3	15	3	7
Potassium ferricyanide	11.25	10	20	10	2.3	10	3	59
Potash alum	45	36.4	10	0.5	..	40	10	..
Ammonium alum	..	..	..	..	20.5	..	..	..
Citric acid	11.25	10	..	1	..	..	..	..
Salt	..	..	53	..	..	..	..	..
Glacial acetic acid	..	..	7-14	..	..	..	..	..
Hydrochloric acid	..	..	..	..	3	15	1	..

1. Hewitt; 2. Rennie; 3. Weissermel; 4. Schmidt; 5. Garner; 6. Rennie; 7. Rennie; 8. Quentin.

After the print has been bleached in the above baths, it should be immersed in a 5 per cent solution of sulphuric acid for 5 minutes, and then washed.

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	1	2	3	4	5	6
Chromic acid	5	1.4	2.2	2	1-2	2
Potassium bromide	20	14	19.8	18	20	30
Cupric sulphate	..	28	33	30	30	18

1. Namias; 2. Smith; 3. Anon.; 4. Schrott; 5. Wurm-Reitmayer; 6. Duvivier.

	1	2	3	4	5	6	7	8	9	10	11	12
Cupric sulphate	20	12	..	40	43	40	22	30	9.2	10.4	11.5	10
Cupric bromide	..	..	50	..	..	..	..	..	..	..	..	..
Potassium bromide	10	8	..	40	43	20	20	30	9.2	10.4	11.5	10
Potassium bichromate	10	2	1	2	1.4	1	2	15	.8	1.2	..	0.8
Potash alum	..	..	..	..	..	..	..	10	..	..	..	..
Chrome alum	..	..	..	..	..	..	..	..	1.8	2.3	..	2
Sulphuric acid	..	..	..	..	..	..	..	..	0.5	0.6	0.6	0.6
Glacial acetic acid	..	..	..	..	..	..	..	40	..	..	..	..
Potassium chromate	..	..	..	..	..	..	..	..	..	..	1.15	..

1. A. B. W.; 2. Mortimer; 3. Ermen; 4. Namias; 5. Seeman; 6. Brum de Canto; 7. Bendorf; 8. Weissermel; 9. Featherstone; 10. Featherstone; 11. Gillin; 12. Wellington & Ward.

	1	2	3	4	5	6	7	8	9	10	11
Cupric sulphate	29	28	30	24	7.5	15	18	10	25	12.5	27
Potassium bromide	29	32	30	20	5	10	18	8	25	..	..
Potassium bichromate	4.6	..	..	..	3.75	7	3	1	5	1.5	..
Ammonium bichromate	..	4	5	10	..	..	..	..	..	..	47
Hydrochloric acid	0.46	0.4	0.5	1.5	1	2	1	..	.5	..	1.0
Sulphuric acid	..	..	..	..	..	..	..	..	..	0.5	..
Potash alum	..	..	..	..	..	..	..	..	.5	..	..
Salt	..	..	..	..	..	..	..	..	..	69	13.5

1. Mayer; 2. Karpinski; 3. Tolkowsky; 4. Switkowski; 5. Birmingham Phot. Co.; 6. Rennie; 7. Mayer; 8. Namias; 9. Sturenburg; 10. Garner; 11. Switkowski.

The quantities of the ingredients given in the above tables (Mebes) are for a total volume of 1000 parts of solution.

The dried print may be soaked either in water, or a 2½ to 5 per cent solution of sulphuric acid for about 5 minutes, and then washed. The surface moisture should be blotted off and inking proceeded with. Dilute alkaline solutions may also be used, about 1 per cent caustic potash, soda or ammonia, 5 per cent of the carbonates, or 10 per cent salt or calcium chloride. The print should be placed face up on a sheet or two of wet blotting paper, supported on a sheet of glass, and dabbed with a linen pad. Special brushes and inks are obtainable for this process, or the ink may be applied with a velvet roller. The inks may be obtained in almost every

colour, and either the special inks, or lithographic, or photo-gravure inks may be used. Artist's powder colours may also be used, and worked up on a slab with a palette knife with medium, boiled linseed oil, or raw oil with a little janner's gold size. The inks dry very slowly, and it has been suggested to treat the completed print with certain solvents for the medium, such as benzol, benzol and alcohol, petroleum ether, gasoline, etc. These are dangerous, and the best is carbon tetrachloride. The print is rinsed once or twice with the solvent, and then dried. This treatment gives a somewhat dead appearance in the shadows; then ordinary celluloid varnish, diluted with 2 to 3 parts of amyl acetate may be used, the prints immersed therein for a minute, and dried.

OIL PRINTING.—This is a process worked out by G. H. Rawlins, which is practically based on the older processes of Poitevin and Mariot. Gelatinised paper is sensitised with a bichromate, exposed under a negative, thoroughly washed, soaked in water for an hour, and then inked up, either with a roller or brushes, charged with greasy ink, which only takes on the exposed parts.

Special papers, pigmoil or oil printing, can be obtained commercially; or paper may be floated on a 6 per cent solution of soft collotype gelatine for a few minutes and hung up to dry. It should be sensitised with the following:

Ammonium bichromate	60 g	460 gr.
Water	1000 ccm	16 oz.

For use mix 1 part stock solution with 2 parts denatured alcohol. Place the paper face up on a flat board or sheet of glass, and apply the sensitiser freely with a pad of absorbent cotton or soft linen, a flat brush or a Blanchard brush. The alcoholic solution will not keep. The paper may also be immersed in a 5 per cent solution of ammonium bichromate

for five minutes and dried. After exposure the image should be seen in a brown colour on the yellow ground of the paper, and should be rapidly washed until all trace of the sensitiser is removed. Then it should be allowed to soak in water at 25° to 28° C. (77° to 82° F.) for 10 minutes, placed face up on a damp pad or sheet of glass, the surface moisture removed, and the ink applied. The further treatment is as for the bromoil process.

AQUARELLE PRINTING.—The preparation of the prints is exactly the same as for oil printing, but, instead of using oil pigments, thick water colour pigments are used.

OILOGRAPH.—This is a modification of the bromoil process, in which a plain gelatine paper is used. A good bromide print is soaked in water for 5 minutes, then squeegeed into contact with the gelatinised paper, which has been soaked for 2 to 2½ minutes at 16° C. (60° F.) in the following:

Potassium bichromate	11 g	84 gr.
Potassium ferricyanide	7.5 g	58 gr.
Potassium bisulphate	0.625 g	3 gr.
Potassium bromide	7.5 g	58 gr.
Chrome alum	1.6 g	11 gr.
Water	1000 ccm	16 oz.

The print and the paper should be allowed to remain in contact under slight pressure for 20 minutes, then separated, and the print washed, when it can be redeveloped and used again. The gelatine-coated paper, after stripping, is placed in water at 32° C. (90° F.) for a few minutes; then a relief begins to show, and it can be inked up as usual. Either single or double transfer carbon paper may be used for the gelatinised paper.

MAKING BROMOIL TRANSFERS.—Presses are obtainable commercially, which practically consist of two superimposed rollers, with flat beds on each side for supporting the transfer

pads. It is possible to use an old print burnisher, but the gears interlocking the two rollers should be removed so that the lower roller is driven by the pressure only. Or the domestic wringer, with rubber or hard wood rollers may be used. A very simple means of obtaining transfers was suggested by Minuth, which consists of rubbing instead of rolling, using a hardwood tool, shaped as shown in Fig. 6,

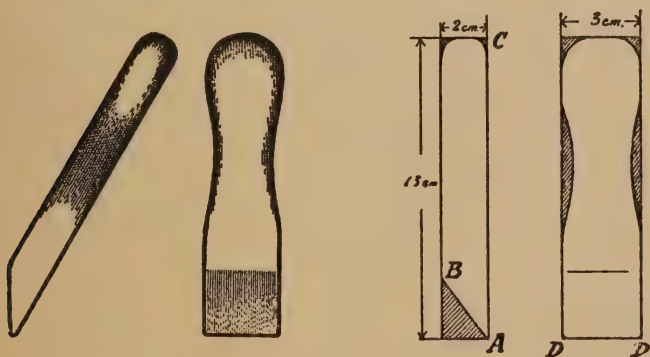


Fig. 6

practically a wooden chisel with rounded edge. The rubbing should not be done direct on the bromoil, but preferably on a sheet of waxed paper, and this may also be used for masks to keep the margins of the paper clean. Registration pins are also useful, especially in multiple transfer. These can be made by passing a flat-headed drawing pin through a piece of thin cardboard about $2\frac{1}{2} \times 2\frac{1}{2}$ inches, and then gluing another piece of card on the back of the first one so as to cover the head of the pin. When dry the cards are cut as close to the head of the pin as possible. Two of these should be made. Two holes should be punched through the bromoil at opposite sides, and the back and front of the print,

just around these holes, painted with celluloid varnish. This is to prevent the absorption of water around the holes, so that they will not be deformed and thus cause non-registration in subsequent printings.

Any paper may be used to transfer to, but the soft copper-plate or collotype papers are the best, as they absorb the ink slightly and give a more velvety appearance. It is important that the paper be lightly sized, otherwise the surface may tear in patches. A good size can be made by boiling 2 per cent of starch in water, and this can be painted over the surface with a flat brush. Too much size prevents transfer. Hard, thick papers may be soaked in water and placed between thick fluffless blotters under light pressure for a little time to even the dampness.

Fig. 7 shows the laying of the transfer paper on the marked

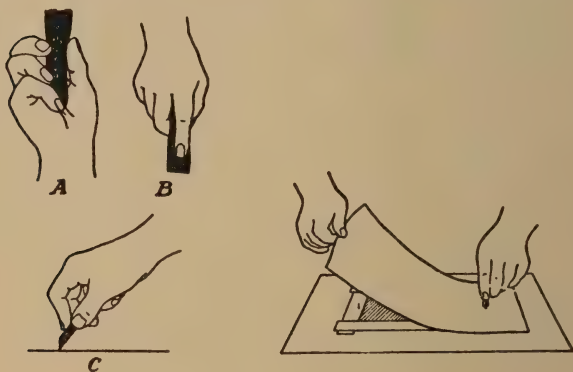


Fig. 7

bromoil and the method of fitting the pins. *A*, *B* in Fig. 7 show the correct way to hold the tool and *C* the correct angle for this. The strokes may be either elongated ovals as in *A*,

Fig. 8, or zig-zag lines as in *B*. While rubbing, the paper should be held firmly down with the other hand close to the tool. It is preferable to use a normal relief and a soft ink rather than a hard one and high relief. When two transfers are to be made on the same paper it is advisable to dust the

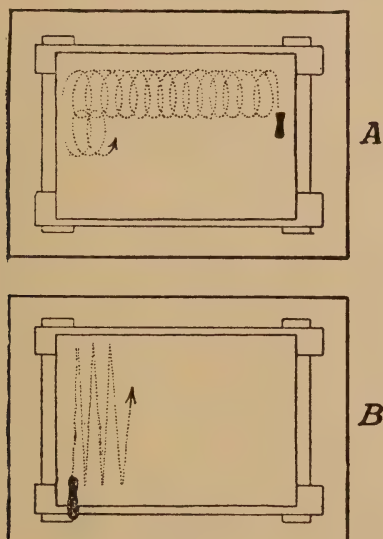


Fig. 8

first with talcum powder. Care must be taken in fitting the paper on the registration pins; one should be fitted first into the hole and a cork slipped over it to prevent the paper slipping off and then the other fitted into place. In using this transfer process for three-colour work care must be taken to keep everything at as even a temperature as possible. It is advisable also to mark around two corners of the bromoil with pencil lines, which with the pins facilitates registration. A sheet of thin celluloid should be placed over the print and the outlines of a few prominent objects traced on the cellu-

loid, and without shifting the celluloid the registration pins driven through it. Then the celluloid should be laid on the second colour print, the sketched-in outlines made to coincide and the pins driven through the print. The third print is treated in the same way.

Another simple method was suggested by Böhm, as shown in Fig. 9, in which *a* is a sheet of plate glass on which is



Fig. 9

placed a sheet of fluffless, smooth blotting paper, then on this the freshly inked bromoil *b*, and then a sheet of smooth, hard drawing paper *c*. The latter is preferably fastened at one end to the glass plate so as to prevent it shifting. As a roller a knitting needle of one-eighth inch diameter is used, which can be seen as the little round circle between the boards. Pressure is obtained by means of the top board. The transfer can be examined after it has been rolled, and if unsatisfactory can be rolled again in the same direction. For prints larger than 5 x 7 it is preferable to use a rather more elaborate arrangement, shown in Fig. 10. This acts well up to 16 x 20.

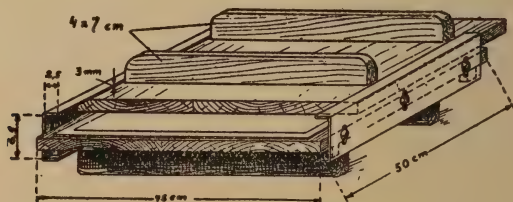


Fig. 10

On each of its longer sides a U-shaped iron strip is fastened by two or three screws; the holes must be about two-fifths

of an inch long, as can be seen on the side shown, so that the screws may work up and down. On the lower surfaces of the U-iron are fastened some pieces of soft rubber. Real soft rubber, such as used for erasing, should be used, and the number of pieces will depend on the softness. On the base-board is placed first a sheet of linoleum or soft blotting paper, then the fluffless sheet, then the bromoil and the transfer paper. It is also advisable to cover the transfer paper with a sheet of smooth firm drawing paper, and the layers under the bromoil should not be too soft or it may wrinkle up. The pressure or top board is of the same thickness as the bottom one. It is important that this board ride smoothly between the ways, and the handles shown on top facilitate pressing it to and fro. The knitting needle is used as in the smaller arrangement. Increased pressure can be obtained by using more papers under the bromoil. It is very important that the top piece does not warp and the cross pieces, which should be screwed to it, with the heads of the screws well sunk in, will prevent this. If necessary the iron ways may be greased to make the board move more freely.

The bromide print for transfer must be very clean and free from fog. Soft ink should be used, and, therefore, the relief must be kept rather high. The arrangement of the transfer block, ready for passage through a roller press, should be as follows: two or four thin cards should be used and over these a sheet of thin smooth linoleum, then a sheet of thick blotting paper. On this should be placed the transfer paper, and the position of the bromoil having been previously marked by pencil lines at two opposite corners, the inked bromoil should be placed in position and then the same arrangement of blotting paper, linoleum and cards placed on top, as used under the paper. Great care must be taken that there is no sliding action when putting the bromoil in posi-

tion, otherwise a smear will be caused. At first very light pressure should be used and with each passage of the block through the machine it should be increased. The transfer can easily be examined by removing the top pack, lifting one corner of the bromoil, while holding the main part down with a stiff card or straight edge, and the rolling continued if the transfer is not enough. If a second pull is desired it is advisable to free the bromoil from any trace of the ink by swabbing with a solvent, such as carbon tetrachloride. It must be again immersed in water before inking up again. The number of pulls possible from one bromoil varies with the hardness of the gelatine film and may be from five to twenty-five.

ANOTHER BROMOIL TRANSFER PROCESS.—A direct print or enlargement should be developed with a non-tanning developer, such as amidol, fixed in a plain hypo bath, well washed, and then bleached in the following:

Potassium bromide	10 g	77 gr.
Cupric sulphate	15 g	115 gr.
Potassium bichromate	5 g	38.5 gr.
Water	1000 ccm	16 oz.

Dissolve in the above order, and add sufficient hydrochloric acid to form a clear solution. After complete bleaching, wash well, and treat with a 1 per cent sulphuric acid bath to remove any yellow colour. Again wash, fix in a 20 per cent solution of hypo, and wash. Immerse the print for 10 minutes in:

Glycerine	333 ccm	5 oz.
Water	667 ccm	10 oz.

Place face up on a clean glass plate, and roll down with a roller squeegee. Now fasten the edges down to the glass with strips of gummed paper. Ink up with a roller with a greasy ink, litho or collotype. If the paper is too much hardened, the ink will take on the parts which should be white; then it

should be immersed again in the glycerine solution at a temperature of 30° C. (86° F.), or until the ground shows a distinct relief ; then stick down again to the glass and ink up. It is stated that at least 100 pulls can be taken from this, and, of course, in any colour. The process is also applicable to three-colour work.

Miscellaneous Printing Processes

THE POWDER PROCESS.—This process is based on the fact that colloids lose their tackiness on exposure to light in contact with a bichromate. It is rarely used for paper prints, and its chief application has been for the preparation of reversed and duplicate negatives for photo-mechanical work, or for making ceramic enamels. For the latter process the image was produced on collodionised glass to facilitate stripping, and the image transferred to the enamel plaques.

The following are typical formulæ:

Dextrine	40 g	307 gr.
White sugar	50 g	384 gr.
Ammonium bichromate	20 g	154 gr.
Water	1000 ccm	16 oz.
Glycerine	20 to 80 drops	10 to 40 drops

Or:

Gum arabic	20 g	154 gr.
White sugar	25 g	192 gr.
Ammonium bichromate	20 g	154 gr.
Alcohol	50 ccm	$\frac{3}{4}$ oz.
Water	1000 ccm	16 oz.

The alcohol should be added after all the other ingredients are dissolved. Or:

Dextrine	48 g	368 gr.
Grape sugar	48 g	368 gr.
Potassium bichromate	48 g	368 gr.
Water	1000 ccm	16 oz.

Or (Miethe):

Gelatine	5.8 g	44.5 gr.
Rock sugar candy	194 g	3 oz., 177 gr.

Potassium bichromate	58 g	445 gr.
Water	1000 ccm	16 oz.

Soak the gelatine and the candy in the water for 30 minutes, dissolve by heat, and add the bichromate, Or (Vogel) :

A. Gum arabic	160 g	1 oz.
Sugar	400 g	2½ oz.
Honey	80 g	½ oz.
Water	400 g	2½ oz.
Alcohol	60 ccm	900 min.

Use warm water to dissolve the gum, sugar, and honey, and then add the alcohol; to this should be added a few drops of glycerine in dry weather.

B. Ammonium bichromate, 10% sol.

For use mix 1 part A, 2 parts B, and 3 parts water, heat to 50° C. (122° F.), and filter twice.

Plate glass should be flowed with one of the above solutions, the excess drained off, the plate dried in a level position at 63° C. (145° F.), and exposed while still warm. As the powder only adheres to the unexposed parts, a transparency must be used and not a negative, if a positive is required. In bright sunlight the exposure will be from 1 to 2 minutes, or until the image is faintly visible. The plate should then be again warmed, until hotter than the room in which the work is carried out, and placed on a sheet of white paper. A fine powder, such as graphite, sifted on to the surface from a fine muslin bag, is gently brushed over the whole surface with a very soft brush. As the unexposed parts absorb moisture, the powder will adhere, and gently breathing on the film will cause it to adhere more quickly. As soon as the image is intense enough, the excess powder should be brushed off, the plate coated with 2 per cent plain collodion, and, when this is set, immersed in a 5 per cent solution of alum until free from

yellow stain, then rinsed and dried. Instead of using the collodion, the plate may be treated with:

Sulphuric acid	75 ccm	1 oz.
Water	300 ccm	4 oz.
Methyl alcohol	600 ccm	8 oz.

until all yellow colour disappears, then gently washed with water, and dried. The image is very tender and very liable to damage. If it is not to be stripped from the glass, it is advisable to give the glass a preliminary coating of a 2 per cent solution of sodium silicate.

THE PEPPER DUSTING-ON PROCESS.—

A. White pepper	400 g	8 oz.
Benzole	1000 ccm	20 oz.

Allow to stand for 24 hours with frequent shaking; then filter.

B. Gum dammar	50 g	1 oz.
Benzole	1000 ccm	20 oz.

C. Solution of rubber in benzole; bicycle tire cement will do. For use mix 10 parts A, 1 part B, 1 part C, filter, coat any surface, and dry in the dark. Expose under a transparency for a few minutes in the sun, dust over with any dry litho or other colour, or bronze. Finally brush clean with a soft brush.

NEGROGRAPHIC PROCESS (*Itterheim*).—Smooth well-sized paper should be rather thickly coated with:

Gum arabic	250 g	4 oz.
Water	1000 ccm	16 oz.

The gum should be in clear small lumps and preferably suspended in a fine muslin bag in the water, which may be warm. When all has dissolved, add:

Potassium bichromate	50 g	384 gr.
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When this has dissolved, add:

Alcohol	10 ccm	77 min.
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The paper should be hung up to dry. The exposure, under a line drawing, is from 5 to 10 minutes in diffused light, or until the image is distinctly visible. Immerse in water, not too cold, until the lines of the drawing show a distinct relief. It should then be surface dried with a soft pad of cloth, and hung up to dry. Then coat with:

Shellac	50 g	384 gr.
Lampblack	150 g	2½ oz.
Alcohol	1000 ccm	16 oz.

The shellac should be dissolved first, filtered, and then the lampblack worked in. A flat brush or soft pad should be used for applying this to the print, which, after complete coating of the surface, should be immersed in a 2 to 3 per cent solution of sulphuric or hydrochloric acid, until on gentle application of a soft brush or pad the black pigment comes away from the ground leaving the lines of a good intense black.

ANTHRACOTYPE (*Sobacchi*).—Well-sized paper should be coated with a gelatine solution:

Gelatine	33 g	258 gr.
Water	1000 ccm	16 oz.

Allow to soak for 15 minutes, melt at 40° to 50° C. (104° to 122° F.), and filter. Immerse the paper for 10 minutes in water, then place face up on a sheet of glass, and lightly squeegee into contact, or a soft linen pad may be used. The edges of the paper should be turned up to the height of about 1 cm. (¾ in.) so as to form a dish, and the gelatine solution poured in, allowing 620 ccm per qm (2 oz. per sq. ft.). As soon as the gelatine has set, hang up to dry. This paper will keep indefinitely. To sensitise immerse for 2 minutes in a 4 per cent solution of potassium bichromate, and dry in the dark; this paper will keep for about a week. Expose under a drawing from 12 to 60 seconds in sunlight until the image is

faintly visible. Immerse in running or frequently changed water, until all trace of yellow disappears. Then immerse in water at 28° to 30° C. (82° to 86° F.) for one minute, immediately place face up on a sheet of glass or flat board, and remove surface moisture with fluffless blotters or a soft linen pad. Finely powdered lampblack or other powder should be dusted over the surface through fine muslin; a small sieve can easily be made from a lidless box. Then a soft round badger brush should be used with circular strokes to distribute the powder, which should only adhere to the unexposed parts. When the image is fully visible, the print should be exposed to the sun or in a moderately warm oven, not over 60° C. (140° F.), until completely dry. At this temperature the gelatine softens, and the powder sinks slightly into it. When thoroughly dry, immerse in cold water until it lies quite flat, then place face up on a board, and rub the surface gently with a soft pad until the ground is white. Should the powder not adhere sufficiently to the lines, the powdering operation may be repeated as often as necessary, a warm water bath being used each time, and, if necessary, the temperature raised a few degrees to thoroughly soften the gelatine. The print then only requires drying.

THE ANILINE PROCESS (*Willis*).—The basis of this process is the reduction of a bichromate by the action of light and the formation of an aniline colour on the exposed salt by the vapour of aniline or like compound.

Well-sized paper should be floated on (Reynolds):

Potassium bichromate,		
sat. sol.	1000 ccm	16 oz.
Sulphuric acid	45 ccm	345 min.
Or (Dawson):		
Ammonium bichromate	104 g	798 gr.
Glacial phosphoric acid	42 to 126 g	323 to 968 gr.

Water	1000 ccm	16 oz.
Or (Vogel) :		
Potassium bichromate	5 g	38.5 gr.
Phosphoric acid, sp. gr. 1.124	500 ccm	8 oz.
Water	500 ccm	8 oz.
Or (Weissenberger) :		
Potassium bichromate	100 g	770 gr.
Sulphuric acid	133 ccm	1020 min.
Water	1000 ccm	16 oz.
The sulphuric acid in this formula may be replaced by 122 ccm (936 min.) phosphoric acid, sp. gr. 1.117.		
Or (Weissenberger) :		
Potassium bichromate	66.6 g	512 gr.
Potassium bisulphate	300 g	2304 gr.
Manganese sulphate	26.6	205 gr.
Water	1000 ccm	16 oz.
Or (Weissenberger) :		
Potassium bichromate	75 g	576 gr.
Sodium acid phosphate	200 g	1536 gr.
Magnesium chloride	75 g	576 gr.
Water	1000 ccm	16 oz.

This last is said to be the best formula.

Paper, which must be free from wood pulp, should be floated on one of the above for from 1 to 2 minutes and rapidly dried. Exposure in diffused light will vary from 10 to 60 minutes, according to the thickness of the paper on which the drawing is made. In sunlight the exposure will be about one-third of the time. Development is best effected by laying the paper at the bottom of a box to the lid of which is pinned a sheet of stout blotting paper moistened or sprayed with:

Commercial aniline	500 ccm	8 oz.
Benzole	500 ccm	8 oz.

The image should appear in a few minutes and will be a dirty blackish-green. The colour is somewhat dependent on the duration of the aniline fuming; the shorter this is the bluer the final print; the longer the time the more blue-black the colour. The fuming time is dependent on the exposure. When the image is intense enough, immerse the paper in water, running or frequently changed, until the whites are pure. If the whites will not clear, immerse the print in a 1 per cent solution of sulphuric or 3 per cent hydrochloric acid; then wash, and the green will be formed, which can be converted into blue by treatment with a 1 per cent solution of ammonia.

ANILINE BLACK OR ENDEMANN'S PROCESS.—This is also sometimes called vanadium printing. Aniline black is formed by the action of a vanadium salt. The sensitiser is:

Salt	31 g	238 gr.
Potassium bichromate	31 g	238 gr.
Sodium vanadate	0.043 g	0.33 gr.
Sulphuric acid	65 ccm	500 min.
Water	1000 ccm	16 oz.

Well-sized paper, preferably sized with a 2 per cent solution of gelatine, is floated on the above or the solution may be applied with a brush and dried. Exposure should be about 7 minutes in diffused light, and the print should then be exposed to the vapour of a 2 per cent solution of aniline in warm water, which should be heated in a dish. The image will appear in a brown colour and the paper should then be exposed in a very damp room or box at 24° to 30° C. (75° to 86° F.) for about 2 hours, or until quite black. Finally, it should be washed with dilute ammonia, 1:6, and dried.

FEERTYPE, PRIMULINE AND DIAZOTYPE PROCESSES.—These processes are but rarely used and are more applicable to fabrics than to paper. They are based on the light-sensi-

tiveness of complex organic compounds, which under the action of light form coloured dye images. Feer suggested the following:

A. Sodium toluoldisazosulphonate	25 g	192 gr.
Beta-naphthol	25 g	192 gr.
Caustic soda	8 g	61 gr.
Water	1000 ccm	16 oz.

Gives scarlet red images.

B. Sodium ditolyltetrazosulphonate	25 g	192 gr.
Metaphenylendiamine	20 g	154 gr.
Water	1000 ccm	16 oz.

Gives brown images.

C. Sodium ditolyltetrazosulphonate	25 g	192 gr.
Resorcine	22 g	169 gr.
Caustic soda	16 g	122 gr.
Water	1000 ccm	16 oz.

Gives orange images.

D. Sodium ditolyltetrazosulphonate	30 g	230 gr.
Resorcine	20 g	154 gr.
Caustic soda	15 g	115 gr.
Water	1000 ccm	16 oz.

E. Sodium ditolyltetrazosulphonate	30 g	230 gr.
Alpha-naphthol	25 g	192 gr.
Caustic soda	7 g	54 gr.
Water	1000 ccm	16 oz.

F. Sodium ditolyltetrazosulphonate	30 g	230 gr.
Paraphenylendiamine	20 g	154 gr.
Water	1000 ccm	16 oz.

A, B, C can be used alone; D and E mixed in equal volumes for violet tones; or E and F in equal volumes for blue tones.

After exposure, which is about 5 minutes in sunlight, the prints should be washed in water acidulated with hydrochloric acid.

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The primuline process was patented by Green, Cross and Bevan. The process is as follows:

Primuline	33 g	253 gr.
Hot water	1000 ccm	16 oz.

Filter and immerse the fabric in the warm solution for about 10 minutes, wash thoroughly, and immerse for 5 minutes in:

Sodium nitrite (not nitrate)	6.6 g	51 gr.
Hydrochloric acid	15 ccm	115 min.
Water	1000 ccm	16 oz.

Dry in the dark. Exposure must be made under a positive, if a positive print is required. Then the print is thoroughly washed, and treated with one of the following developers.

For red tones:

Beta-naphthol	10 g	77 gr.
Caustic soda	13 g	100 gr.
Water	1000 ccm	16 oz.

For orange tones:

Resorcine	2.5 g	19 gr.
Caustic soda	11 g	84 gr.
Water	1000 ccm	16 oz.

For purple:

Alpha-naphthylamine	20 g	154 gr.
Hydrochloric acid	3 ccm	23 min.
Water	1000 ccm	16 oz.

For blacks:

Eikonogen	13 g	100 gr.
Water	1000 ccm	16 oz.

For brown:

Pyrogallol	12 g	92 gr.
Water	1000 ccm	16 oz.

The prints must be well washed after development, and if on fabric ironed before quite dry. Unfortunately, it is almost impossible to obtain pure whites by this process.

Andresen suggested the following process:

Benzidine	23 g	177 gr.
Water	1000 ccm	16 oz.

Boil until dissolved, and add:

Sulphuric acid	37.5 ccm	288 min.
Water	37.5 ccm	288 min.

Allow the mixture to cool; then with the aid of ice reduce the temperature to 5° to 10° C. (41° to 50° F.), and a copious precipitate should be formed. Add slowly:

Sodium nitrite (not nitrate)	18 g	138 gr.
Water	50 ccm	¾ oz.

Stir until a clear solution is obtained, and pour into:

Alcohol	5000 ccm	80 oz.
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The diazobenzidine will be precipitated. Filter and wash with alcohol two or three times, and dissolve in:

Water	1000 ccm	16 oz.
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During solution the water must be kept cooled down to 5° C. (41° F.). This precipitate must not be allowed to dry, as it is very explosive. Keep the solution cool, and float paper on the surface, or immerse fabrics completely. Dry in the dark, and expose under a positive. The developer may be a 2 per cent solution of amido-naphthol-sulphonic acid-5 or the corresponding -9 compound with 2 per cent caustic soda.

Andresen also patented the following process:

Water	150 ccm	5 oz.
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Heat in a porcelain dish to boiling, and add:

Beta-naphthylamine	14.3 g	220 gr.
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Add slowly:

Hydrochloric acid, sp. gr. 1.19	10 ccm	152 min.
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Stir until dissolved, and add with constant stirring:

Hydrochloric acid	40 ccm	617 min.
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Cool the thick paste with ice to 5° C. (41° F.), preferably by adding the ice to the liquid, and add with constant stirring:

Sodium nitrite

10 g

154 gr.

Filter into an ice-cold dish. Paper should be floated on the cold solution, or fabric immersed, wrung out, and dried in the dark. Exposure under a negative will be from 8 to 12 minutes in diffused light, and the image shows in a brown colour on the yellow ground. Development should be effected with a 10 per cent solution of fused sodium acetate, which gives brownish-red tones. If alpha-naphthylamine be used, brownish-grey tones are obtained. Better colours are obtained by adding a little of the sensitising solution to the developers. The prints should be subsequently washed, and dried.

Schoen patented the use of diazotised ortho-amido-salicylic acid and its compounds for obtaining coloured prints on paper and fabrics, red tones being given, which can be altered by treatment with various compounds, such as ferric chloride, lead acetate, cobalt nitrate, lime or baryta water.

Mountants

DEXTRINE—An excellent preparation, when properly made, which keeps well and adheres firmly :

White dextrine	1000 g	1 lb.
Alum	40 g	280 gr.
Sugar	156 g	2½ oz.
Water	1200 ccm	19¼ oz.
Phenol (carbolic acid)	3 ccm	22 min.

Mix the dextrine with the water, boil for 5 minutes, add the sugar and the alum ; stir until dissolved, allow to cool slightly, add the phenol, and cast into wide-mouthed bottles. Inferior dextrine gives a coloured paste ; the alum is preferably left out, as it may subsequently cause fading of the prints. If the bottles filled with the paste are cooled for several days in a refrigerator, the paste sets to a white firm mass. A simpler formula is :

White dextrine	1000 g	1 lb.
Water	625 ccm	10 oz.
Wintergreen or clove oil	10 ccm	60 drops

Or :

White dextrine	1000 g	1 lb.
Water	1500 ccm	24 oz.
Oil of wintergreen	2 ccm	12 min.
Oil of cloves	2 ccm	12 min.

Place the water in a vessel standing in a water bath, and keep the temperature at 71° C. (160° F.) ; stir in the dextrine slowly, and, when it has all dissolved, add the oils. Set in a cool place for several days, when it will congeal to a firm white paste.

DEXTRINE AND GUM.—A very adhesive paste :

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Picked white gum arabic	62.5 g	½ oz.
Dextrine	290 g	2¼ oz.
Ammonia	1 ccm	4 drops
Phenol (carbolic acid)	15 ccm	60 min.
Water	1000 ccm	8 oz.

Powder the gum, and mix with the dextrine into a smooth paste with one-fourth of the water; then add the rest of the water, and boil for 10 minutes. Strain through linen, and add the phenol and ammonia when cold.

GELATINE.—This must be used hot. A piece of ground glass should be dipped in hot water, drained, and the mountant brushed over. The print is then laid face up on the pasted surface, rubbed gently into contact with a piece of paper, and is then pressed on to its mount:

Soft gelatine	187.5 g	3 oz.
Water	750 ccm	12¼ oz.

Soak the gelatine in the water, melt in a water bath, and add slowly with constant stirring:

Methyl alcohol	225 ccm	4 oz.
Glycerine	25 ccm	96 min.

It is preferable to omit the glycerine, and use corn or sugar syrup, or add sugar in the same proportion.

LIQUID GELATINE.—

Gelatine	100 g	1 oz.
Water	600 ccm	6 oz.
Chloral hydrate	100 g	1 oz.

Soak the gelatine in the water, melt by the aid of heat, add the chloral, heat for 15 minutes, and then add sodium carbonate until the mixture is neutral to litmus paper.

STARCH-GELATINE.—

A. Bermuda arrowroot	200 g	8 oz.
Water	100 ccm	4 oz.
B. Soft gelatine	20 g	360 gr.
Water	1600 ccm	64 oz.

Soak the gelatine in the water and melt with heat. Rub the arrowroot into a cream with the water, add to the gelatine solution, and boil 10 minutes, with constant stirring. Allow to cool, add add:

Methyl alcohol	125 ccm	5 oz.
Phenol	1.3 ccm	25 min.

STARCH PASTE.—This will not keep longer than a week:

Pure starch	100 g	1 oz.
Benzoic acid	1.2 g	6 gr.
(Or salicylic acid)	2.5 g	15 gr.
Water	1200 ccm	12 oz.

Rub the starch and the acids into a very stiff paste with a little water; it should be so stiff that it is difficult to stir. Add the rest of the water boiling, and stir well, when a clear smooth paste should be formed. If it is not quite clear, boil for a few minutes. Allow to get quite cold, and take off the skin that forms on the surface. Somewhat increased keeping power is obtained by the addition of formaldehyde, 1.2 ccm (6 min.), which should be added when the paste is cold. Wheat or preferably rice starch should be used.

DRY MOUNTING (*Briand*).—

Shellac, white or pale yellow	300 g	5 oz.
Denatured alcohol	333 g	5½ oz.

Dissolve.

Gum elemi	30 g	230 gr.
Denatured alcohol	333 ccm	5½ oz.

Dissolve:

Canada balsam	50 g	384 gr.
Denatured alcohol	334 ccm	5 oz.

Dissolve, and mix the three solutions. Paint on tissue paper, and allow to dry for 5 minutes, then paint the other side and dry. Place between mount and print, and pass a hot iron over the two.

Stereoscopic Work

SEPARATION OF THE LENSES.—This should be equal to the interpupillary distance of the eyes, which is approximately 65 mm (2 9/16 in.), but 76 mm (3 in.) is usually adopted for normal work. When taking near objects, the centers of the lenses must be brought nearer to one another, and the rule for finding how much is: if the additional extension of the camera beyond the infinity mark or focus is equal to the focal length multiplied by $1 \div r$, then the separation must be reduced by an amount equal to the maximum separation multiplied by $1 \div (r + 1)$, in which r is the ratio of image to object. Example, the image is to be made one-quarter the natural size, then $1 \div (r + 1) = 1/5$, so that the separation must be $3 - 3/5$ inches.

MOUNTING PRINTS.—To secure correct conditions of convergency, each print must be seen under the same angle of view as that at which it was produced, and the two prints must be mounted in accord with the following rule:

Let P = separation of any pair of corresponding points on prints

N = separation of same points on negatives

E = separation of eyes (average is 64 mm)

L = separation of camera lenses.

A non-prismatic stereoscope being used:

1. If image points represent infinitely distant objects,
Make $P = E$.
2. If only near objects are shown, and an ordinary single plate double lens stereo camera has been used,
Make $P = E + L - N$
3. If a single camera is used for two separate exposures, or

if two separate similar cameras are used together, measure N with negatives placed edge to edge, and in the same relative positions that they occupied during exposure; then

Make $P = E - N + \text{length of one plate.}$

If a prismatic stereoscope, fitted with properly centred half lenses, is used, add the width of one prism to above values of P .

Frequently, if the prints are cut apart, errors may arise, and they may be wrongly mounted. To avoid this, place the prints face down on the table, with the top away from you, and across the central dividing line draw a faint pencil line, about one inch long. Then cut the prints in two, and, after trimming, mount them so the pencil lines fall on the outside margins of the prints.

In order that the picture shall be viewed as through a dark frame, which is the most effective way, trim the prints as follows: the prints should be $2\frac{1}{2}$ inches wide, but mounted with an eighth of an inch between them, and trimmed so that there is one-eighth of an inch more subject shown on the right-hand side of the left-eye print than on the right of the right-eye print, and one-eighth of an inch more subject shown on the left of the right-eye print than on the left of the left-eye print.

Lantern Slides

STANDARD SIZES.—British, $3\frac{1}{4} \times 3\frac{1}{4}$ in.; American, $4 \times 3\frac{1}{4}$ in. Maximum size of picture 3×3 in. in both cases.

SPOTTING.—The standard spotting in Britain and the Colonies is with two round spots of colour distinct from that used for the binding, placed at the top of the picture, when viewed as it appears in nature. These spots go downward, and next the condenser when projecting. The American standard method is to spot with one “thumb-spot” at the bottom left-hand corner of the picture, as viewed in its proper direction. This spot is covered by the thumb of the right hand, when the lantern is fed from the right hand side, and is at the upper right-hand corner, next to the condenser, during projection.

ADHESIVE FOR BINDING STRIPS.—

Sugar candy	100 g	240 gr.
Water	100 ccm	$\frac{1}{2}$ oz.

Dissolve by heat, and add to:

Fish glue	400 ccm	2 oz.
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Brush on thin needle (black) paper, dry, and cut into strips. The strips may better be purchased when only small quantities are needed.

LANTERN SLIDE DIAGRAMS.—Draw with a hard pencil on fine ground glass, and varnish with a strong solution of gum dammar in benzole. Or coat plain glass with:

Sandarac	16.5 g	128 gr.
Mastic	16.5 g	128 gr.
Ether	800 ccm	13 oz.
Benzole	165 ccm	$2\frac{1}{2}$ oz.

This gives a fine grain and takes the pencil well. To make it again transparent, coat with:

Sandarac	30 g	240 gr.
Mastic	30 g	240 gr.
Ether	1000 ccm	16 oz.

DIAGRAM LANTERN SLIDES.—

Canada balsam	4 parts
Pure turpentine	8 parts
Liquid siccative	1 to 2 parts

Mix thoroughly, and add as much lampblack as will give it the consistency of an ointment. Coat glass evenly with a badger hair softener. Or:

Syrian asphalt	50 parts
Yellow Venice turpentine	10 to 12 parts
Linseed oil or varnish	15 parts
Pure turpentine	15 parts

Melt the asphalt and Venice turpentine in the turpentine by heat, and add the linseed oil with continual stirring. Add enough lampblack to make it as thick as ointment. Well-cleaned glass should be coated with this until opaque, and allowed to dry; then rubbed over with a little lampblack rubbed up with gum water. This will be repelled at first but with continual working will take. A good-sized darning needle mounted in a wooden handle may be used as the graving tool. Broad surfaces may be scraped out with a sharp knife. The above give white lines on a black ground.

DEVELOPMENT.—Numerous formulas have been proposed for lantern slide plates. A few American manufacturers' formulas are given, and are adaptable to other brands.

Hammer Transparency Plates.—

Metol	2 g	30 gr.
Sodium sulphite	62.5 g	2 oz.
Hydrochinon	15.6 g	½ oz.

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Sodium carbonate	78 g	2½ oz.
Potassium bromide	2 g	30 gr.
Citric acid	2 g	30 gr.
Water	1000 ccm	32 oz.

Extreme Density Developer. Hammer Plates.—

Hydrochinon	12.5 g	¼ oz.
Sodium sulphite	100 g	2 oz.
Sodium carbonate	150 g	3 oz.
Potassium bromide	6.25 g	⅛ oz.
Water	1000 ccm	20 oz.

Use full strength at 65° F.

Seed Lantern, Black Tone Transparency Plates. —

A. Elon (metol)	4 g	30 gr.
Hydrochinon	4 g	30 gr.
Sodium sulphite, dry	17 g	130 gr.
Water	1000 ccm	16 oz.
B. Potassium bromide	2 g	15 gr.
Sodium carbonate, dry	13 g	100 gr.
Water	1000 ccm	16 oz.

For use mix in equal volumes. Temperature about 70° F.

Seed Hydrochinon Developer for Warm Tones.—

A. Hydrochinon	6.5 g	50 gr.
Sodium sulphite, dry	2.6 g	20 gr.
Potassium bromide	0.65 g	5 gr.
Citric acid	0.65 g	5 gr.
Water	1000 ccm	16 oz.
B. Sodium carbonate, dry	31.25 g	½ oz.
Caustic soda	3.9 g	30 gr.
Water	1000 ccm	16 oz.

For use mix in equal volumes. For still warmer tones use more B.

Cramer's Hydrochinon-Pyrocatechin Developer.—

A. Sodium sulphite, dry	180 g	6 oz.
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Pyrocatechin	16 g	240 gr.
Hydrochinon	16 g	240 gr.
Potassium bromide	8 g	120 gr.
Water	960 ccm	32 oz.
B. Caustic potash	16 g	240 gr.
Water	960 ccm	32 oz.
Mix in equal volumes.		

Enlarging

TABLE FOR ENLARGING AND REDUCING.—

A.	2	3	4	6	7	8
B.	$3-1\frac{1}{2}$	$4-1\frac{1}{3}$	$5-1\frac{1}{4}$	$7-1\frac{1}{6}$	$8-1\frac{1}{7}$	$9-1\frac{1}{8}$
A.	9	10	11	12		
B.	$10-1\frac{1}{9}$	$11-1\frac{1}{10}$	$12-1\frac{1}{11}$	$13-1\frac{1}{12}$		

To find the number of linear times of enlargement or reduction, divide the longer side of the enlargement by the longer side of the negative. Then find this number in the top row A, and multiply the lens focus by the numbers in the lower row B. The greater distance is that between the lens and sensitive paper, and the lesser that between the lens and negative. Example: To enlarge 5 x 4 to 20 x 16. As $20 \div 5 = 4$, if a 6-inch lens be used, the distances will be respectively $6 \times 5 = 30$ and $6 \times 1\frac{1}{4} = 7\frac{1}{2}$ in. For reducing, the relative positions of the sensitive surface and negative or copy are reversed, thus to reduce a 20 x 16 four times with a 6-inch lens, the latter will be 30 inches from the subject and $7\frac{1}{2}$ inches from the plate.

RELATIVE EXPOSURES WHEN ENLARGING (WITHOUT A CONDENSER) (*B. J. Almanac*).—

New Times of Enlarge- ment	Time of enlargement for which exposure is known.											
	1	1½	2	2½	3	3½	4	5	6	8	10	12
1	1	1½	2	2½	3	3½	4	5	6	8	10	12
1½	1½	1	1½	1	1½	1	1½	1	1½	1	1½	1
2	2½	1½	1	1	1½	1	1½	1	1½	1	1½	1
2½	3	2	1½	1½	1	1½	1	1½	1	1½	1	1
3	4	2½	1½	1½	1	1½	1	1½	1	1½	1	1
3½	5	3½	2½	1½	1½	1	1½	1	1½	1	1½	1
4	6	4	3	2	1½	1½	1½	1	1½	1	1½	1
5	9	6	4	3	2½	1½	1½	1	1½	1	1½	1
6	12	8	5	4	3	2½	1½	1	1½	1	1½	1
8	20	13	9	7	5	4	3½	2½	1½	1	1	1
10	30	19	13	10	7	6	5	3½	2½	1½	1	1
12	42	27	19	14	11	8	7	4½	3½	2	1½	1

To use this table find in the top horizontal line the number of times of enlargement for which exposure is known. Under this number the relative time of exposure for different degrees of enlargement will be found opposite the new times of enlargement in first vertical column.

RELATIVE EXPOSURES WHEN COPYING OR REDUCING (*B. J. Almanac*).—

New Scales of Reduction	Scale of reduction for which exposure is known.											
	1	¾	⅔	½	⅓	¼	⅕	⅙	⅛	⅒	⅓	⅔
1	1	¾	⅔	½	⅓	¼	⅕	⅙	⅛	⅒	⅓	⅔
¾	¾	1	⅔	½	⅓	¼	⅕	⅙	⅛	⅒	⅓	⅔
⅔	⅔	⅔	1	½	⅓	¼	⅕	⅙	⅛	⅒	⅓	⅔
½	½	½	½	1	⅓	¼	⅕	⅙	⅛	⅒	⅓	⅔
⅓	⅓	⅓	⅓	⅓	1	¼	⅕	⅙	⅛	⅒	⅓	⅔
¼	¼	¼	¼	¼	¼	1	⅕	⅙	⅛	⅒	⅓	⅔
⅕	⅕	⅕	⅕	⅕	⅕	⅕	1	⅙	⅛	⅒	⅓	⅔
⅙	⅙	⅙	⅙	⅙	⅙	⅙	⅙	1	⅛	⅒	⅓	⅔
⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	1	⅒	⅓	⅔
⅒	⅒	⅒	⅒	⅒	⅒	⅒	⅒	⅒	⅒	1	⅓	⅔
⅓	⅓	⅓	⅓	⅓	⅓	⅓	⅓	⅓	⅓	⅓	1	⅔
⅔	⅔	⅔	⅔	⅔	⅔	⅔	⅔	⅔	⅔	⅔	⅔	1

To use this table find in the top horizontal line the scale of reduction for which exposure is known. Under this scale the relative time of exposure for different degrees of reduction will be found opposite the new scales of reduction marked in first vertical column.

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SOLAR PRINTING.—Frequently used for making enlargements with plain surfaces for working-up with crayon, water colour and oils:

Potassium iodide	16.5 g	125 gr.
Ammonium bromide	7.3 g	50 gr.
Ammonium chloride	2 g	16 gr.
Gelatine	12.5 g	96 gr.
Albumen	110 ccm	1¾ oz.
Water	1000 ccm	16 oz.

Soak the gelatine in three-fourths of the water for 30 minutes, melt in a water bath, add the salts, cool down to about 38° C. (100° F.), add the albumen, which should have been previously whipped to a froth and allowed to liquefy, and add enough water to make up to bulk. Apply to the paper with a sponge or Blanchard brush, and dry. Sensitise with:

Silver nitrate	100 g	1½ oz.
Glacial acetic acid	50 g	¾ oz.
Water	1000 ccm	16 oz.

Apply with sponge or brush, and dry. The exposure with a good light will be about 60 seconds. The developer is:

Gallic acid	12.5 g	96 gr.
Lead acetate	2 g	16 gr.
Water	1000 ccm	16 oz.

Add just before use a little of the silver nitrate solution. Apply with brush or sponge. Or:

Milk	1000 ccm	16 oz.
Glacial acetic acid	38 ccm	288 min.

Stir well, filter, and add to the filtrate:

Potassium iodide	14.5 g	112 gr.
Potassium bromide	3.5 g	27 gr.

Paint over the paper, and dry quickly. To sensitise, float on or paint with:

Silver nitrate	84 g	642 gr.
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Glacial acetic acid	126 ccm	2 oz.
Water	1000 ccm	16 oz.
Develop with:		
Pyrogallol	6.25 g	48 gr.
Glacial acetic acid	83 ccm	640 min.
Citric acid	0.13 g	1 gr.
Water	1000 ccm	16 oz.
Or coat with:		
Arrowroot	20 g	154 gr.
Potassium iodide	10 g	77 gr.
Salt	30 g	230 gr.
Citric acid	1 g	8 gr.
Water	1000 ccm	16 oz.

Heat the mixture until a clear liquid is formed, and float the paper, or paint the solution on with brush or sponge. Dry.

Float the paper for 5 minutes on:

Silver nitrate	75 g	576 gr.
Citric acid	5 g	38 gr.
Water	1000 ccm	16 oz.

Expose until the outlines appear, and float on:

Gallic acid	2 g	15 gr.
Glacial acetic acid	10 g	77 gr.
Water	1000 ccm	16 oz.

When the image is dense enough, float the print on repeated changes of water, and fix in a 20 per cent solution of hypo.

CASEIN PAPER.—Dissolve as much fresh casein as possible in 100 ccm of strong ammonia, precipitate with dilute hydrochloric acid, press the mass through linen, allow to dry, and powder it:

Casein, as above	300 to 400 g	5 to 6½ oz.
Water	1000 ccm	16 oz.

Boil until dissolved, and add:

Boric acid	11.5 g	88 gr.
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Hydrochloric acid	11.5 ccm	88 gr.
Citric acid	7 g	54 gr.
Water	800 ccm	12¾ oz.

Allow the mixture to cool, remove the skin, press through a fine cloth, coat the paper, and dry. This will keep any length of time. The paper is salted by floating on:

Ammonium bromide	20 g	154 gr.
Magnesium iodide	48 g	370 gr.
Magnesium chloride	8 g	61 gr.
Water	1000 ccm	16 oz.

This should be sensitised on:

Silver nitrate	100 g	768 gr.
Glacial acetic acid	40 ccm	307 min.
Water	1000 ccm	16 oz.

Small sheets may be floated, and large ones can be painted with the solution. Expose while damp until the details are visible, and develop with:

Gallic acid	20 g	154 gr.
Lead acetate	10 g	77 gr.
Glacial acetic acid	75 ccm	576 min.
Water	1000 ccm	16 oz.

After development immerse the print in weak soda solution, and fix.

Flashlights

METHODS OF USE.—Flashlights may be divided into two classes: A, pure magnesium powder blown through a flame; and B, magnesium mixed with some substance, rich in oxygen, which can be fired with a cap, electric or pyrophoric spark, etc. The first named are less used at the present time than the second class, and they require no comment, as special lamps to burn alcohol, benzolene gas, etc., can be obtained commercially.

Gunpowder was one of the first compounds used for firing the second class of flashlights; but it soon gave place to gun-cotton or pyroxyline, the usual proportions being pyroxyline 1 part, magnesium 2 parts. The cotton should be pulled out to a loose long tuft and the magnesium sprinkled over it. Strips of thin celluloid may be used in the same way, firing being effected by a long taper or match tied to the end of a stick. The manufacture of flashlights is exceptionally dangerous, and should not be undertaken by any but experienced chemists.

MIXTURES OF MAGNESIUM WITH NITRATES.—In all cases, the weight given should be mixed with 1 part of magnesium powder. Thorium nitrate, 0.5; this must be dried at 100° C. (212° F.) before mixing. Strontium nitrate, 1.5; must also be dried. Potassium nitrate, 1.5. Ammonium nitrate, 2; not advisable as the salt is hygroscopic, and the mixed powder will not keep well. Sodium nitrate, 3. Cadmium nitrate, 1; basic cadmium nitrate must be used, which can be made as follows: dissolve 100 g (3½ oz.) cadmium nitrate in 100 ccm (3½ oz.) hot water in a porcelain dish, add a few drops of 10 per cent solution of caustic soda, until a precipitate is

formed. Evaporate until dry, dry for some time at 105° C. (220° F.), and reduce to powder. Lithium carbonate, 1; alone with magnesium or mixed with one of the above, gives a red light. Potassium permanganate, 1.3; does not explode when struck; gives brown smoke and more sparks than others. Manganese dioxide, 1; should be very finely powdered. Perfectly safe, burns fairly rapidly with little smoke.

CHLORATES, PERCHLORATES, ETC.—Potassium chlorate, 2 or 1; must be powdered. Potassium perchlorate, 2; also in powder. Sometimes a mixture of the two is used, as chlorate, $\frac{3}{4}$, perchlorate, $\frac{3}{4}$. Both the salts must be in fine powder before mixing, and should preferably be mixed with a feather on a sheet of paper, as strong friction is apt to cause an explosion. These compounds cannot be sent through the post. Potassium or ammonium persulphate, 2. Potassium or ammonium bichromate, 2; burns rather slowly. Chrome alum, anhydrous, 1; a perfectly safe mixture.

FLASH SHEETS.—Flash sheets may be prepared by suspending magnesium powder in celluloid or pyroxyline solution, casting on glass and stripping before quite dry. The following mixture has also been proposed:

Magnesium	1 part
Potassium chlorate	2 parts
Celluloid varnish	3 parts

To be used in the same way. Another method proposed is to coat paper with starch paste, rub magnesium powder into it, and dry. Thin blotting paper, soaked in solution of potassium bichromate and dried, is thus pasted and dried.

FLASH CANDLES.—Slow-burning mixtures can easily be made, and the so-called time-light candles are small tubes of paper, impregnated either with pyroxyline solution or potassium nitrate, and filled with a magnesium compound. Or the containers may be made of thin aluminium foil, 0.1 to

0.3 mm thick ($1/25$ to $1/8$ inch). Typical mixtures are as follows (Novak):

Magnesium 2.5, cerium nitrate 1.75, strontium carbonate 0.75; burns in $5\frac{1}{2}$ seconds.

Magnesium 2.5, cerium nitrate 1.5, strontium carbonate 1; burns in 4.5 seconds.

Magnesium 2.5, cerium nitrate 1.25, strontium nitrate 1; burns in 1.3 seconds.

Magnesium 2.5, strontium nitrate 1, strontium carbonate 1; burns in 1.3 seconds.

Magnesium 2.5, strontium nitrate 1, strontium carbonate 1.5; burns in 4.3 seconds.

Magnesium 2.5, magnesium carbonate 2.5; burns in 11.2 seconds.

Anhydrous salts must be used in all cases.

So-called orthochromatic candles can be prepared by incorporating certain salts, which give coloured lights. For red, lithium carbonate 1, with the strontium mixture given above. For yellow, sodium nitrate 5. For green, cupric sulphate 2, barium nitrate 2.

SLOW-BURNING POWDERS.—Slow combustion of flash powders is also obtained by an admixture of shellac; for instance, 1 part of shellac is melted by heat with 9 parts of strontium nitrate stirred in, allowed to cool, and powdered. Or magnesium 6, potassium chlorate 12, antimony sulphide 2; or magnesium 2.5, strontium nitrate 5, strontium carbonate 2.5, amorphous phosphorus 0.25, have also been recommended; but the fumes are poisonous. Bethge patented the following mixtures, of which 2 to 3 g burn in 30 seconds: magnesium 2.5, cerium oxalate 1.5; magnesium 2.5; cerium oxalate 1.5, vanadic acid 0.08; magnesium 2.5, cerium oxalate 1; magnesium 2.5, calcium oxalate 0.75; magnesium 2.5, cerium oxalate 0.5, calcium oxalate 0.5; magnesium 2.5, manganese

oxide 5; magnesium 2.5, cerium oxalate 0.5, manganese oxide 0.25. The chromates or tungstates of thorium may also be used, and the mixtures keep well and give little smoke, such as magnesium 1, thorium chromate 2. Lumière patented the use of the chromates of iron, manganese, chromium, nickel, cobalt, aluminium, cerium, lead, copper and antimony, as giving little smoke. Boric and silicic acid have also been patented when added in equal quantity to the magnesium, and these mixtures are non-explosive, give little smoke and almost as much light as the permanganate mixtures.

Aluminium may be used in place of magnesium, but it does not give quite so actinic a light. It may also be mixed with magnesium. A slow-burning aluminium mixture is aluminium 6, potassium nitrate 6, barium nitrate 6, dextrine 2, sulphur 1. The aluminium powder is sometimes greasy and clumps together; in this case, it should be mixed with benzole, petroleum ether, gasoline, or as these are dangerous, carbon tetrachloride may be used. The mixture should be well shaken, the powder allowed to settle, the liquid poured off, and the powder allowed to dry.

AMOUNT OF FLASHLIGHT POWDER NEEDED.—Orostini gives the following table of the quantity of magnesium and stop to be used:

Distance of object from light	Quantity of magnesium in grams				
	$f:7$	$f:9$	$f:12$	$f:18$	$f:25$
1 meter	0.07	0.01	0.2	0.4	0.8
2 meters	0.28	0.04	0.8	1.6	3.2
3 meters	0.63	0.09	1.8	3.6	7.2
4 meters	1.21	1.06	3.2	6.4	12.8

MAGNESIUM FOR UNDERGROUND WORK.—Martel divides the subjects into two classes: (1) short distances from 15 to 20 meters, and (2) long distances from 15 to 60 meters. For the shorter distances he recommends three or four strips

of magnesium ribbon, 3 mm broad and 0.5 meters long, wound into a spiral torch which gives an exposure of from $1\frac{1}{2}$ to 3 minutes; from three to six of these spirals will give exposures from 15 to 20 minutes; up to 10 meters one spiral is enough; up to 15 meters three or six should be used. Placing magnesium powder in 5 g lots and firing with a tuft of pyroxyline, one charge will be enough up to 10 meters; for greater distances successive charges should be fired. Flash powders are not satisfactory; they are dangerous and give more smoke. For longer distances blow-through lamps should be used, using about 8 g up to 60 meters; up to 40 meters 5 g.

DURATION OF FLASH.—Londe states that the duration of a flash is dependent on various factors; but, calling the unknown ingredients of a powder X, the following table gives the duration: 1. X 100, magnesium 150, duration of flash, 0.07 seconds; 2. X 100, magnesium 175, duration of flash, 0.10 seconds; 3. X 100, magnesium 225, duration of flash, 0.11 seconds; 4. X 100, magnesium 250, duration of flash, 0.12 seconds.

Old powder fires more slowly than freshly mixed. The weight of the charge plays a part in the duration: 1 g burns for 0.03 seconds, 2 g for 0.05 seconds, and 3 g for 0.07 seconds.

The particular manner in which the powder is laid also affects the flash: 1 g in a heap burns for 0.2 seconds, while 1 g spread out burns for 0.4 seconds.

The method of firing also affects the duration: Electric, duration 0.14 seconds; percussion cap, 0.144 seconds; match, 0.188 seconds; touch paper, 0.280 seconds.

Any flash longer than 0.12 seconds will show movement of the eyes.

Colour Photography

THREE-COLOUR FILTERS.—The quantity of dyes is given in grams per square meter and grains per 1000 square inches. An 8 per cent solution of gelatine should be prepared (see Orthochromatics).

Red filter :

Rose Bengal	1.25 g	12.53 gr.
Tartrazine	2.0 g	19.9 gr.

Green filter :

Naphthol green	0.4 g	3.98 gr.
Patent blue	0.2 g	1.99 gr.
Tartrazine	1.0 g	9.95 gr.

Blue-violet filter :

Acid rhodamine	0.6 g	5.97 gr.
Toluidine blue	1.8 g	17.91 gr.

The usual quantity of dyed gelatine is 700 ccm per qm (15 oz., 435 min., per 1000 sq. in.).

ADDITIVE FILTERS.—These are used for additive projection or with the photochromoscope. The gelatine should be prepared as previously described.

Blue-violet filter :

Crystal violet	1.38 g	2.63 gr.
Methylene blue	0.46 g	0.876 gr.

A few drops of glacial acetic acid should be used to dissolve the above. Allow the same quantity of dyed gelatine to the same area.

Green filter :

Tartrazine	0.533	5.3 gr.
Patent blue	0.089 g	0.883 gr.
Naphthol green	0.178 g	1.76 gr.

The green filter is always difficult to adjust, and it is advisable to make four or five of different depths, increasing the quantity of dye by one-fifth each time.

Red filter:

Tartrazine	2.03 g	20.17 gr.
Rose Bengal	1.77 g	17.132 gr.

In order to prevent the double reflection from the back of the plain mirrors in the chromoscope, under the red filter should be placed a plain glass coated on the back with:

Patent blue	0.0285 g	0.284 gr.
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Under the blue filter, should be placed a plain mirror coated with:

Tartrazine	0.0142 g	0.142 gr.
Naphthol green	0.023 g	0.227 gr.
Patent blue	0.0345 g	0.340 gr.

AUTOCHROME PLATES.—Primary developer:

A. Pyrogallol	30 g	230 gr.
Potassium bromide	30 g	230 gr.
Sodium bisulphite lye	2 drops	1 drop
Water to	1000 ccm	16 oz.
B. Sodium sulphite, dry	100 g	77 gr.
Ammonia, sp. gr. 0.92	150 ccm	2 oz., 252 min.
Water to	1000 ccm	16 oz.

For use this stock solution should be diluted with 3 times its volume of water. The actual developer is:

Solution A	100 parts
Solution B, diluted	100 parts
Water to	1000 parts

To compensate for errors in exposure and variations in temperature, the following system was devised: Have ready in a small measure 45 ccm (345 min.) of dilute B solution to be added wholly or partly to the bath during development, if necessary. As soon as the plate is in the developer, count

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the number of seconds from the moment of entering until the appearance of the first outlines of the image, exclusive of the sky in landscapes. The number of seconds elapsing before the appearance of the image is the guide to the further development of the plate, which should be carried out according to the following table:

Time of first appearance of image Seconds	Quantity of ammonia solution B diluted to $\frac{1}{4}$ strength to be added after image appears ccm	Total time of development including time of appearance	
		Minutes	Seconds
22 to 24	None	2	0
25 to 27	2	2	15
28 to 30	8	2	30
31 to 35	15	2	30
36 to 41	20	2	30
42 to 48	25	2	30
49 to 55	30	2	45
56 to 64	35	3	0
65 to 75	40	4	0
over 75	45	5	0

The additional quantity of B solution must be added when the outlines begin to appear.

Almost every developing agent has been suggested, but the following are satisfactory:

Sodium sulphite, dry	50 g	384 gr. 702
Ammonia, sp. gr. 0.92	33 ccm	253 min.
Potassium bromide	6 g	46 gr. 73
Metol	4 g	31 gr.
Hydrochinon	12 g	92 gr. 46
Water to	1000 ccm	16 oz.

Or:

Metol	6.5 g	50 gr.
Hydrochinon	2.10 g	16 gr.
Sodium sulphite, dry	40 g	307 gr.
Potassium bromide	2.5 g	19 gr.

Sodium hyposulphite	0.10 g	0.77 gr.
Ammonia, sp. gr. 0.88	20 ccm	154 min.
Water to	1000 ccm	16 oz.

For use dilute with an equal volume of water. The small quantity of hypo causes the image to reverse in this solution, and development should be carried on until the highlights or flesh tones just begin to show reversal, when viewed against the light. Instead of using hypo, an excellent developer is obtained by using potassium ferrocyanide, 4 g (31 gr.).

The following is stated to commence the development from the bottom of the film :

Amidol	6.6 g	51 gr.
Sodium sulphite, dry	19 g	145 gr.
Sodium bisulphite lye	19 ccm	145 min.
Potassium bromide	1.9 to 3.3 g	14.6 to 25 gr.
Water	1000 ccm	16 oz.

Reversing solution :

A. Potassium permanganate	2 g	15 gr.
Water	500 ccm	8 oz.
B. Sulphuric acid, c. p.	10 ccm	77 min.
Water	500 ccm	8 oz.

Mix in equal volumes just before use. The A solution must be kept in the dark. The following is preferable, being free from some disadvantages of the permanganate :

Potassium bichromate	5 g	38 gr.
Sulphuric acid, c. p.	10 ccm	77 min.
Water	1000 ccm	16 oz.

SECOND DEVELOPMENT.—Any developer may be used for the second development after reversal; the makers recommend :

Sodium sulphite, dry	15 g	115 gr.
Amidol	5 g	38 gr.
Water	1000 ccm	16 oz.

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INTENSIFICATION.—The following silver intensifier was recommended by the makers:

A. Pyrogallol	3 g	23 gr.
Citric acid	3 g	23 gr.
Water	1000 ccm	16 oz.
B. Silver nitrate	5 g	84 gr.
Water	100 ccm	3½ oz.

For use add 10 parts B to 100 parts A, and immediately apply to the plate. The mixed solutions rapidly turn cloudy; then the solution should be poured away, and fresh applied. This should not take more than about 30 seconds, as a rule; then the plate should be well washed, immersed in a 2 per cent solution of the clearing bath, well washed, and fixed. The following intensifier may also be used:

Cupric sulphate	20 g	154 gr.
Potassium bromide	20 g	154 gr.
Hydrochloric acid	5 ccm	38 min.
Water	1000 ccm	16 oz.

As soon as the plate is bleached, rinse rapidly, and treat with a 5 per cent solution of silver nitrate; then clear in a neutral permanganate bath, and redevelop with amidol or treat with a 5 per cent solution of sodium bisulphite.

VARNISHING.—The makers recommend:

Gum dammar	200 g	3½ oz.
Benzole	1000 ccm	16 oz.

The following is preferable as being less dangerous as regards fire risks:

Gum dammar	20 g	154 gr.
Manilla copal, powdered	50 g	384 gr.
Carbon tetrachloride	1000 ccm	16 oz.

As soon as the resins are dissolved, the mixture should be heated to the boiling point, and then filtered while hot.

THE PAGET PLATE.—With this a separate panchromatic

plate is exposed in close contact with the taking screen, developed in the usual way and fixed, washed and dried. From this negative a positive is printed by contact and bound up with a viewing screen.

As a rough guide the exposure with $f:8$ in good light with sunshine for an open landscape is about $\frac{1}{4}$ second. For portraiture, head and shoulders, outdoors in diffused light, $f:8$, about 3 seconds. Snap shots should not be attempted except in the brightest light at $f:6.5$ and not less than $1/10$ second. The speed of the plate is approximately 11 Watkins, F24 Wynne with filter and taking screen. A special developer is issued by the makers, but any one may be used if diluted with an equal volume of water. Green light or total darkness must be used, unless desensitising is adopted.

The transparency must be of a black tone, free from fog, brilliant and full of detail. Special plates and developers are made for this work.

THE AGFA PLATE.—This plate is of the combined type, like the Autochrome, and must be placed in the plateholder glass side to the lens. A special compensating filter is obtainable, which may be placed in front of or behind the lens, and in the latter position it lengthens the focus about 1.5 mm. The exposure is about 60 to 80 times that required for a rapid plate and for a sunny landscape about midday with $f:6.8$ one second exposure should be correct.

The developer recommended is:

Metol	12.5 g	96 gr.
Hydrochinon	5 g	38½ gr.
Sodium sulphite, dry	80 g	614 gr.
Potassium bromide	4.8 g	37 gr.
Ammonia, sp. gr. 0.91	25.5 ccm	196 min.
Water	1000 ccm	16 oz.

Dissolve the metol and hydrochinon in warm water and add

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the sulphite and bromide. When the solution is cold add the ammonia. For use mix 1 volume with 3 of water and use at 18° C. (65° F.). Development time, 3 minutes. Then rinse slightly and immerse in the following reversing bath:

Potassium bichromate	5 g	38 gr.
Sulphuric acid	10 ccm	77 min.
Water	1000 ccm	16 oz.

The plate may now be handled in daylight and after about 3 minutes in this bath it should be washed for 30 seconds and reimmersed in the developer for about 2 minutes. Then wash in running water for 3 minutes. Drying should be effected in a warm place, but not by heat. The plate may be varnished by gently heating first and then coating with 3 per cent solution of gum dammar in benzole.

Photomechanical Processes

The wet collodion process, collodion emulsion, lead, copper, and acid silver intensifiers, and reducers are dealt with in other sections. See index.

CLEANING ZINC AND COPPER.—For line work very fine pumice powder should be applied with a felt pad or soft scrubbing brush and water and applied in the same direction as the original lines of the polish. For half-tone work on zinc or copper well washed whiting made into a paste with water and a little ammonia should be used with a swab of absorbent cotton. Or, for copper, American polishing charcoal, with rounded end, may be used in straight lines with plenty of water.

PASSING OR GRAINING BATH FOR ZINC.—

Powdered alum	31.25 g	½ oz.
Nitric acid	3.125 ccm	24 min.
Water	1000 ccm	16 oz.

GRAINING BATH FOR COPPER.—

Chromic acid	23 g	175 gr.
Water	1000 ccm	16 oz.

ALBUMEN SENSITISER FOR LINE WORK ON ZINC.—

Albumen (white of egg)	23 ccm	175 min.
(Or dried albumen)	6.5 g	50 gr.
Potassium bichromate	5.2 g	40 gr.
Water	1000 ccm	16 oz.

FISH-GLUE SENSITISER.—

Fish glue	47.5 ccm	365 min.
Ammonium bichromate	0.132 g	1.04 gr.
Water	1000 ccm	16 oz.

Add enough ammonia to give a bright yellow colour. This

film must be burnt in after development.

INKING-UP LINE PRINTS ON ZINC.—Use photo-transfer ink, thinned down with very little turpentine, and apply with compo or fine nap leather roller.

DEVELOPING LINE PRINTS.—Immerse the plate in water, to which a few drops of ammonia have been added, and rub with swab of absorbent cotton.

HARD ENAMEL FOR ZINC.—

Fish glue	650 ccm	10½ oz.
Fresh white of egg	130 ccm	2 oz.
(Or dried albumen)	9.2 g	70 gr.
Ammonium bichromate	15 g	115 gr.
Ammonia	15 drops	10 drops
Water	1000 ccm	16 oz.

Beat the albumen to a froth and mix in the glue and again beat up, allow to stand eight hours, then dissolve the bichromate, then add the ammonia and filter through absorbent cotton. The following gives a much tougher film:

Fish glue	187.5 ccm	3 oz.
Belting cement, Le Page's	93.75 ccm	1½ oz.
Ammonium bichromate	15.6 g	120 gr.
Albumen	187.5 ccm	3 oz.
Ammonia	7.8 ccm	60 min.
Water	1000 ccm	16 oz.

Or:

A. Le Page's belting cement	312.5 ccm	5 oz.
Chromic acid	2.85 g	21.75 gr.
Ammonia	11 ccm	87 gr.
Water	1000 ccm	16 oz.
B. Pure rock candy	68 g	524 gr.
Ammonium bichromate	34 g	262 gr.

Add the acid to the water, then the ammonia and finally B with constant stirring.

HARDENING BATH FOR ENAMEL PRINTS ON ZINC.—

Ammonium bichromate	3.55 g	27.5 gr.
Chromic acid	0.3 g	2.3 gr.
Methyl alcohol	143 ccm	2 1/3 oz.
Water	1000 ccm	16 oz.

Immerse the developed plate for from three to five minutes.

DYE SOLUTIONS FOR FISH-GLUE PRINTS.—0.5 per cent solution of methyl violet or eosine.

HALF-TONE ENAMEL FOR COPPER.—

Le Page's fish-glue	200 ccm	3 1/5 oz.
Albumen	131.25 g	2 oz., 44 min.
Ammonium bichromate	2.75 g	213 gr.
Ammonia	33 drops	25 drops
Water	1000 ccm	16 oz.

Beat the albumen to a froth. Allow to stand 8 hours and add the glue and then the salts dissolved in some water, make up to bulk, and filter.

BITUMEN PROCESS.—

Syrian asphalt, fine powder	42.5 g	320 gr.
Chloroform	400 ccm	6 2/5 oz.
Benzole, anhydrous	600 ccm	9 3/5 oz.
Venice turpentine	12.75 g	96 gr.
Oil of lavender	40 drops	32 drops

The coated film should be a transparent golden colour. The exposure is very long even in sunlight. Develop with rectified turpentine.

ETCHING BATHS FOR ZINC.—Weak bath for first bite for line or half-tone, 1 per cent nitric acid. Deep etching for half-tones, 2.5 per cent nitric acid, 1.875 per cent for fine etching half-tones on zinc. For cold enamel:

Nitric acid	15.6 ccm	1/4 oz.
Alcohol, 40%	1000 ccm	16 oz.

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The exposed image is not burnt in, only heated to dry and harden.

SCUM REMOVER FOR COPPER.—

Acetic acid	100 ccm	698 min.
Common salt	187.5 g	3 oz.
Water	1000 ccm	16 oz.

The same quantity of hydrochloric acid may be used instead of the acetic.

MACHINE ETCHING.—Levy machine, first etch, 10 per cent acid for 30 to 40 seconds; second etch, 15 per cent for 1 to 1½ minutes; third etch, 20 per cent for 4 to 5 minutes. Air pressure for first etch, ¼ to ¾ lb.; second and third etches, 1 lb. A single etch with 10 per cent acid for 30 to 40 seconds is generally enough except for extra deep work. For Holt machine and line work on zinc, 7.5 per cent with three bites and rolling up between. Total time for full depth, about 18 minutes. For half-tone on zinc, use the same solution as for line work, for 1½ minutes; then roll up and powder, and etch for 2 minutes.

For half-tone on copper use perchloride of iron solution 35° Bé. or a 35 per cent solution of anhydrous ferric chloride. Air pressure ½ to ¾ lb., time for first bite 30 seconds and total time 3½ to 4 minutes after stopping out. If the iron solution is very acid, add a little ammonia until a slight precipitate is formed, then boil and filter.

COLLOTYPE.—*Grinding New Plates.* Sift over the surface finely sifted emery powder, wet well with water and grind with another plate with circular motion. Wash well after grinding.

Cleaning Old Plates. Soak in 5 per cent caustic potash solution for 4 days or place in hot 10 per cent solution of sodium carbonate. Scrape off old film with hard brush. Re-grind before use.

Substratum.

Whites of fresh eggs	312 ccm	5 oz.
Sodium silicate	125 g	2 oz.
Water	1000 ccm	16 oz.

Beat the whites to froth and allow to settle, filter and add the other ingredients. Pour a little on the plate, drain slightly and place on leveled stand to dry. Or:

A. Gelatine	15 g	115 gr.
Water	500 ccm	8 oz.
B. Alum	10 g	80 gr.
Water	500 ccm	8 oz.

Dissolve the gelatine by heat, add the alum solution warmed up, and add

Sodium silicate sol.	46 g	$\frac{3}{4}$ oz.
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The plates should be warmed and the solution applied with a broad camel-hair brush and dry. A stock of plates may be thus prepared, but they should be rinsed in water and again dried.

Sensitive Solution.

Hard gelatine	46 g	350 gr.
Water	1000 ccm	16 oz.

Allow to soak for 30 minutes and melt and add:

Potassium bichromate	16.5 g	126 gr.
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and filter. Allow 44 min. to every 100 sq. in. (682 ccm per square meter). Place the plates in the drying box and warm up to 48° C. (120° F.), carefully level and coat. The temperature of drying must not exceed 54° C. (130° F.). After exposure wash in water at 15° C. (60° F.) until all trace of yellowness has disappeared, then dry.

Etching the Plate. Actually a moistening solution, there being no etching action. The plate should be rinsed in water, blotted off and covered with a mixture of 3 parts glycerine and 2 parts water for about half an hour. Or equal parts of

glycerine and water plus 2 per cent of ordinary salt may be used.

PHOTOGRAVURE.—Negatives should be full of detail and without hardness and preferably carbon transparencies should be made, showing all details in the high lights, without great density. The thinner these are kept, providing details in the high lights are visible, the better. Special transparency tissue is issued by the makers, or standard brown may be used.

Cleaning the Copper Plate. Rub over with 5 per cent solution of potassium carbonate with cotton swab, rinse well and treat in the same way with 5 per cent solution of sulphuric acid. Wash well and polish with whiting made into paste with 3 per cent solution of ammonia. Rinse plate with hot water and dry with clean cloth.

Graining the Plate. The usual dusting boxes should be used and the longer the time between setting the powdered asphalt in motion and the insertion of the plate the finer the grain. For a coarse grain wait for 20 seconds. Allow the plate to remain for from 2 to 5 minutes. For very fine grain it may be necessary to shake box and grain two or three times. Resin may be used but does not give such good results in unskilled hands.

Setting the Grain. Grip the edge of the plate with a hand vice, using card to protect the copper, and heat over a gas flame, with continual movement so as to even the heat, until a steel blue colour shows.

Mounting Resist. Place the grained plate in water at 21° C. (70° F.), slip in the tissue and brush the face with a soft brush to remove air bubbles. Bring the two into contact and lift from the water, squeegee well, and place between blotters for 10 minutes. Develop with water at 38° C. (100° F.) or if underexposed raise temperature to 49° C. (120° F.).

Rinse in cold water and dry. If etching is to be done at once, flow over with equal parts of methyl alcohol and water and dry on whirler.

Varnishing. The back and edges of plate should be painted with a 20 per cent solution of bitumen in benzole or Mogul varnish thinned down.

Etching Solutions. Anhydrous ferric chloride is used. It is advisable to add to this 6 per cent of freshly precipitated ferric hydroxide, just cover with distilled water, and make solutions up to 43, 40, 38, 36 and 33 degrees Beaumé with distilled water. The following strength solutions correspond to the above: $43^{\circ} = 46$ per cent; $40^{\circ} = 41$ per cent; $38^{\circ} = 39$ per cent; $36^{\circ} = 36$ per cent; $33^{\circ} = 33$ per cent. To each of these the ferric hydroxide may be added, well shaken and allowed to settle for use, or the whole solution made up very strong, heated with the hydroxide and then diluted to the above strengths. The weaker the solution the stronger the etching. As soon as etching is complete, rinse the plate, immerse in 10 per cent solution of caustic potash and rub with swab of cotton. Then rinse, dry, remove grain with benzole, clean plate with 1 per cent nitric acid and finally with washed whiting and ammonia.

PHOTOLITHOGRAPHY.—Transfer paper should be sensitised with a 4.5 per cent solution of potassium bichromate, rendered alkaline with ammonia in winter and with the following in summer:

Potassium bichromate	22.5 g	175 gr.
Manganese sulphate	3.15 g	24 gr.
Water	1000 ccm	16 oz.

Temperature of bath 15° C. (60° F.), time of immersion 5 minutes. It is as well to squeegee the paper to plate glass so that it may dry with a polished surface. After printing place on rolling up board and apply the ink in a very thin

film with a velvet roller. Place in water for about 3 minutes and then roll up again with the roller; this removes the ink and any slight veil can be removed with a wet swab of cotton. Free from water drops by lightly touching with blotting paper and pin to board to dry.

DIRECT PRINTING ON ZINC AND ALUMINIUM.—Sensitise with:

White of egg	62.5 ccm	1 oz.
Fish-glue	15.6 ccm	¼ oz.
Ammonia bichromate	7.8 g	60 gr.
Ammonia	q. s.	q. s.
Water	1000 ccm	16 oz.

Enough ammonia should be added to make the solution a clear lemon yellow. For large plates the volume of the solution may be increased by one-fourth with water.

VANDYKE OR REVERSE PROCESS.—Zinc plates should be grained with the graining bath given for line work and coated with the following:

Fish-glue	111 g	853 min.
Ammonium bichromate	22 g	170 gr.
Chromic acid	0.13 g	1 gr.
Water	1000 ccm	16 oz.

After exposure, under a line copy, develop with plain water and dye up with aniline dye. The plate should then be passed into a bath of:

Ferric chloride, 31% sol.	2 ccm	16 min.
Water	1000 ccm	16 oz.

Leave the plate until the colour disappears, then rinse and dry. Treat the plate with asphaltum washout tincture, and ink up with the following:

Bitumen, powdered	4 parts
Litho chalk printing ink	1 part
Litho writing ink	1 part

Burgundy pitch

1 part

Mix with heat and thin with the minimum of turpentine. There must be but a very thin film of ink on the plate. Allow the plate to dry and develop with water, plain or very slightly acidulated with hydrochloric acid.

Weights and Measures

RULES FOR THE CONVERSION OF WEIGHTS AND MEASURES.

Weights.—

Grains to grams: Take 6 per cent, and add 8 per cent.

Grams to grains: Multiply by 15, then increase result by 3 per cent.

Ounces to grams: Multiply by 28, then increase result by $1\frac{1}{4}$ per cent.

Grams to ounces: Take 3 per cent, and increase it by $1/6 + (5 \text{ per cent of } 1/6)$.

Pounds to kilos: Take 40 per cent, and increase it by $10 \text{ per cent} + (1/3 \text{ of } 10 \text{ per cent})$.

Kilos to pounds: Multiply by 2, then increase result by $10 \text{ per cent} + (2 \text{ per cent of } 10 \text{ per cent})$.

Lengths.—

Inches to centimeters: Multiply by 2, then increase result by $25 \text{ per cent} + (8 \text{ per cent of } 25 \text{ per cent})$.

Centimeters to inches: Take 40 per cent, and diminish it by $1\frac{1}{2}$ per cent.

Yards to meters: Take 70 per cent, and increase it by $30 \text{ per cent} + (2 \text{ per cent of } 30 \text{ per cent})$.

Meters to yards: Add 9 per cent and 4 per cent of 9 per cent.

Fluid Measures.—

Pints to liters: Take 40 per cent, and increase it by $40 \text{ per cent} + (5 \text{ per cent of } 40 \text{ per cent})$.

Liters to pints: Multiply by 2, and diminish result by 12 per cent.

Example: Required the number of grams equal to 15.432 grains:

$$6 \text{ per cent of } 15.432 = 0.92592$$

$$8 \text{ per cent of } 0.92592 = 0.0740736$$

$$0.9999936$$

The result should be 1 g, and the error is less than one in one hundred thousand. In all the above rules, in no case is the error greater than one-thousandth.

Table to convert grams per liter to grains per 16 ounces.—

G per liter	Gr. per 16 oz.	G per liter	Gr. per 16 oz.
1	7.68	10.5	80.64
1.5	11.52	11	84.48
2	15.36	11.5	88.32
2.5	19.2	12	92.16
3	23.04	12.5	96.0
3.5	26.88	13	99.84
4	30.72	13.5	103.68
4.5	34.56	14	107.52
5	38.4	14.5	111.36
5.5	42.24	15	115.2
6	46.08	15.5	119.04
6.5	49.92	16	122.88
7	53.76	16.5	126.72
7.5	57.6	17	130.56
8	61.44	17.5	134.4
8.5	65.28	18	138.24
9	69.12	18.5	142.08
9.5	72.96	19	145.92
10	76.8	19.5	149.76
		20	153.6

To find the number of grams per liter, divide the number of grains per ounce by the following factors:

Oz.	G per liter	Oz.	G per liter
1	0.48	10.5	5.04

1.5	0.72	11	5.28
2	0.96	11.5	5.52
2.5	1.2	12	5.76
3	1.44	12.5	6.0
3.5	1.68	13	6.24
4	1.92	13.5	6.48
4.5	2.16	14	6.72
5	2.4	14.5	6.96
5.5	2.64	15	7.2
6	2.88	15.5	7.44
6.5	3.12	16	7.68
7	3.36	16.5	7.92
7.5	3.6	17	8.16
8	3.84	17.5	8.4
8.5	4.08	18	8.64
9	4.32	18.5	8.88
9.5	4.56	19	9.12
10	4.8	19.5	9.36
		20	9.6

Approximate rule to convert English weights and measures into metric:

1. Call the new volume of solvent 1000 ccm.
2. If any of the ingredients run to ounces, take their ratio to the solvent, and write down the same ratio to 1000 in grams.
3. Divide each grain item by half the number of ounces, and write the result down in grams.

PERCENTAGE SOLUTIONS.—Some dispute has prevailed as to the exact meaning of " x per cent solution," but in photographic practice it means x parts in 100 parts of the total bulk of solution. As most chemicals are sold by the avoirdupois ounce of 437.5 grains, and liquids are measured by the ounce of 480 minims, some confusion has arisen. The following

tables show: (a) the accurate quantities of solids to be dissolved in sufficient liquid to make a total bulk of 100 parts for the various percentages; (b) the number of grains to be dissolved in sufficient solvent to make 1 ounce of any given percentage.

1 per cent	4.375 gr.
2 " "	8.75 "
3 " "	13.125 "
4 " "	17.50 "
5 " "	21.875 "
6 " "	26.25 "
7 " "	30.625 "
8 " "	35.0 "
9 " "	39.375 "
10 " "	43.75 "

The number of grains of a solid which must be dissolved in sufficient liquid to make 1 fluid ounce for the various percentages:

1 per cent	4.8 gr.
2 " "	9.6 "
3 " "	14.4 "
4 " "	19.2 "
5 " "	24.0 "
6 " "	28.8 "
7 " "	33.6 "
8 " "	38.4 "
9 " "	43.2 "
10 " "	48.0 "

These tables are sufficient to calculate any percentage or volume, by merely multiplying or adding. Example: Required to make a 15 per cent solution, how many grains are required:

$$10 \text{ per cent} = 43.75$$

$$5 \text{ per cent} = 21.875$$

$$65.625 \text{ gr.}$$

Required 16 oz. of 10 per cent solution, how many grains required:

$$48 \times 16 = 568 \text{ gr.}$$

The following tables are sufficient to enable anyone to readily convert the metric into the customary units, and are based on those published by the U. S. Bureau of Standards.

Lengths.—

Inches	Centimeters	Inches	Centimeters
0.3937	= 1	1	= 2.5400
0.7874	= 2	2	= 5.0800
1.1811	= 3	3	= 7.6200
1.5748	= 4	4	= 10.1600
1.9685	= 5	5	= 12.7000
2.3622	= 6	6	= 15.2400
2.7559	= 7	7	= 17.7800
3.1496	= 8	8	= 20.3200
3.5433	= 9	9	= 22.8600

Areas.—

Square Inches	Square Centimeters	Square Inches	Square Centimeters
0.1550	= 1	1	= 6.452
0.3100	= 2	2	= 12.903
0.4650	= 3	3	= 19.355
0.6200	= 4	4	= 25.807
0.7750	= 5	5	= 32.258
0.9300	= 6	6	= 38.710
1.0850	= 7	7	= 45.161
1.2400	= 8	8	= 51.613
1.3950	= 9	9	= 58.065

Masses.—

Grains	Grams	Grains	Grams
1	= 0.0648	15.4324	= 1
2	= 0.1296	30.8647	= 2
3	= 0.1944	46.2971	= 3
4	= 0.2592	61.7294	= 4
5	= 0.3240	77.1618	= 5
6	= 0.3888	92.5941	= 6
7	= 0.4536	108.0265	= 7
8	= 0.5184	123.4589	= 8
9	= 0.5832	138.8912	= 9

Liquids.—

Cubic Centimeters	Minims	Cubic Centimeters	Fluid Ounces
1	= 16.230	29.574	= 1
2	= 32.460	59.147	= 2
3	= 48.690	88.721	= 3
4	= 64.920	118.295	= 4
5	= 81.150	147.869	= 5
6	= 97.380	177.442	= 6
7	= 113.610	207.016	= 7
8	= 129.840	236.590	= 8
9	= 146.070	266.163	= 9

The U. S. gallon = 3785.43 ccm; one liter = 33 fld. oz., 391 min.

The above tables apply to the English weights and measures, with the exception of the liquid measures; the English gallon measures 160 fld. oz. = 4545.96 ccm. The following, therefore, must be used for conversion of the same:

Cubic Centimeters	Minims	Cubic Centimeters	Fluid Ounces
1	= 16.894	28.4123	= 1
2	= 33.788	56.8245	= 2

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3	=	50.682	85.2368	=	3
4	=	67.576	113.6490	=	4
5	=	84.470	142.0613	=	5
6	=	101.364	170.4735	=	6
7	=	118.258	198.8858	=	7
8	=	135.152	227.2980	=	8
9	=	153.046	255.7103	=	9

COMPARISON OF THERMOMETER SCALES.—*Equivalence of Centigrade (Celsius) and Fahrenheit Thermometers.*

Centi- grade	Fahren- heit	Centi- grade	Fahren- heit	Centi- grade	Fahren- heit
0	32.0	35	95.0	70	158.0
1	33.8	36	96.8	71	159.8
2	35.6	37	98.6	72	161.6
3	37.4	38	100.4	73	163.4
4	39.2	39	102.2	74	165.2
5	41.0	40	104.0	75	167.0
6	42.8	41	105.8	76	168.8
7	44.6	42	107.6	77	170.6
8	46.4	43	109.4	78	172.4
9	48.2	44	111.2	79	174.2
10	50.0	45	113.0	80	176.0
11	51.8	46	114.8	81	177.8
12	53.6	47	116.6	82	179.6
13	55.4	48	118.4	83	181.4
14	57.2	49	120.2	84	183.2
15	59.0	50	122.0	85	185.0
16	60.8	51	123.8	86	186.8
17	62.6	52	125.6	87	188.6
18	64.4	53	127.4	88	190.4
19	66.2	54	129.2	89	192.2
20	68.0	55	131.0	90	194.0
21	69.8	56	132.8	91	195.8
22	71.6	57	134.6	92	197.6
23	73.4	58	136.4	93	199.4
24	75.2	59	138.2	94	201.2
25	77.0	60	140.0	95	203.0
26	78.8	61	141.8	96	204.8
27	80.6	62	143.6	97	206.6
28	82.4	63	145.4	98	208.4
29	84.2	64	147.2	99	210.2

30	86.0	65	149.0	100	212.0
31	87.8	66	150.8	105	221.0
32	89.6	67	152.6	110	230.0
33	91.4	68	154.4	115	239.0
34	93.2	69	156.2	120	248.0

Chemical Tables

TABLE OF SYMBOLS AND MOLECULAR WEIGHTS OF
THE MORE IMPORTANT COMPOUNDS USED
IN PHOTOGRAPHY

Name	Symbol	Mol. Weight
Acetone	$C_3 H_6 O$	58
— sulphite	$C_3 H_6 OH SO_3 Na$	162
Acid, acetic	$C_2 H_4 O_2$	60
— benzoic	$C_6 H_6 COOH$	122
— boric	$H_3 BO_3$	62
— carbolic	$C_6 H_5 OH$	94
— chlorochromic	$Cl Cr O_2 OH$	136.5
— chromic (anhydride)	$Cr O_3$	100
— citric	$C_6 H_8 O_7 H_2 O$	210
— dithionic	$H_2 S_2 O_6$	162
— formic	$H_2 CO_2$	46
— gallic	$C_6 H_2 (OH)_3 COOH, H_2 O$..	188
— hydrobromic	$H Br$	81
— hydrochloric	$H Cl$	36.5
— hydrofluoric	$H F$	34
— lactic	$CH_3 CH (OH) COOH$	90
— nitric	HNO_3	63
— oxalic	$H_2 C_2 O_4$	126
— pentathionic	$H_2 S_5 O_6$	258
— perchromic	$H Cr O_4$	117
— phosphoric	$H_3 PO_4$	98
— picric	$C_6 H_2 (NO_2)_3 OH$	139
— pyrogalllic	$C_6 H_3 (OH)_3$	126
— salicylic	$C_6 H_4 (OH) COOH$	138
— sulphuric	$H_2 SO_4$	98
— sulphurous	$H_2 SO_3$	82
— tannic	$C_{14} H_{10} O_9$	322
— tartaric	$C_2 H_2 (OH)_2 (COOH)_2$...	150
— tetrathionic	$H_2 S_4 O_6$	225
— trithionic	$H_2 S_3 O_6$	194
Alcohol (methyl)	$CH_3 OH$	32
— (ethyl)	$C_2 H_5 OH$	46
Alum, ammonia	$Al_2 (NH_4)_2 (SO_4)_4 24H_2 O$.	906
— chrome	$Cr_2 K_2 (SO_4)_4 24H_2 O$	998
— iron ammonia	$Fe_2 (NH_4)_2 (SO_4)_4 24H_2 O$.	964
— potash	$Al_2 K_2 (SO_4)_4 24H_2 O$	948

Name	Symbol	Mol. Weight
Aluminium chloride	$\text{Al}_2 \text{Cl}_6 \cdot 12\text{H}_2\text{O}$	267
— sulphate	$\text{Al}_2 (\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	634
— sulphocyanide	$\text{Al}_2 (\text{CNS})_6$	402
Amidol	$\text{C}_9 \text{H}_7 \text{OH} (\text{NH}_2)_2 \cdot 2\text{HCl}$...	197
Ammonia	NH_3	17
Ammonium bichromate	$(\text{NH}_4)_2 \text{Cr}_2 \text{O}_7$	252
— bromide	$\text{NH}_4 \text{Br}$	98
— carbonate	$\text{NH}_4 \text{HCO}_3 + \text{NH}_2 \text{COOH}$ NH_4	—
— chloride	$\text{NH}_4 \text{Cl}$	53.5
— chromate	$(\text{NH}_4)_2 \text{Cr}_2 \text{O}_7$	152
— citrate	$(\text{NH}_4)_2 \text{C}_6 \text{H}_6 \text{O}_7$	226
— iodide	$\text{NH}_4 \text{I}$	145
— molybdate	$(\text{NH}_4)_6 \text{Mo}_7 \text{O}_{24} \cdot 4\text{H}_2\text{O}$	1236
— nitrate	$\text{NH}_4 \text{NO}_3$	80
— oxalate	$(\text{NH}_4)_2 \text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$	142
— persulphate	$(\text{NH}_4)_2 \text{S}_2 \text{O}_8$	228
— phosphate	$(\text{NH}_4)_2 \text{HPO}_4$	132
— sulphate	$(\text{NH}_4)_2 \text{SO}_4$	132
— sulphide	$\text{NH}_4 \text{HS}$	51
— sulphocyanide	$\text{NH}_4 \text{CNS}$	76
— vanadate	$\text{NH}_4 \text{VO}_3$	117
Amyl, acetate	$\text{C}_7 \text{H}_{14} \text{O}_2$	130
— alcohol	$(\text{CH}_3)_2 \text{CH CH}_2 \text{CH}_2\text{OH}$..	88
Aniline	$\text{C}_6 \text{H}_5 \text{NH}_2$	93
Antimony, sulphide	$\text{Sb}_2 \text{S}_3$	336
Aurantia	$(\text{C}_6\text{H}_2(\text{NO}_2)_3)_2 \text{N NH}_4$...	456
Aurine	$\text{C} (\text{C}_6 \text{H}_4 \text{OH})_2 \text{C}_6 \text{H}_4 \text{O}$...	290
Barium, bromide	$\text{Ba Br}_2 \cdot 2\text{H}_2\text{O}$	333
— chloride	$\text{Ba Cl}_2 \cdot 2\text{H}_2\text{O}$	244
— iodide	Ba I_2	391
— nitrate	$\text{Ba} (\text{NO}_3)_2$	261
— peroxide	Ba O_2	201
— sulphate	Ba SO_4	233
Benzole (benzene)	$\text{C}_6 \text{H}_6$	78
Borax (see Sodium Borate)		
Bromine	Br	80
Cadmium, bromide	$\text{Cd Br}_2 \cdot 4\text{H}_2\text{O}$	344
— chloride	Cd Cl_2	183
— iodide	Cd I_2	366
Calcium, carbide	Ca C_2	64
— carbonate	Ca CO_3	100
— chloride (cryst.)	$\text{Ca Cl}_2 \cdot 6\text{H}_2\text{O}$	219
— chloride (fused)	Ca Cl_2	111
— hypochlorite	$\text{Ca} (\text{O Cl})_2$	153
— sulphate	$\text{Ca SO}_4 \cdot 2\text{H}_2\text{O}$	172
— hydroxide (slaked lime)	$\text{Ca} (\text{OH})_2$	74

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Name	Symbol	Mol. Weight
Carbon, bisulphide	$C S_2$	76
Celloidin	$C_{12} H_{10} O_6 (NO_2)_4$	504
Ceric, sulphate	$Ce (SO_4)_2 4H_2O$	404
Chloral hydrate	$C Cl_3 CH (OH)_2$	165.5
Chloroform	$CH Cl_3$	119.5
Chrysoidine	$C_6 H_5 N_2 C_6 H_3 (NH_2)_2$	211.7
Cobalt, chloride	$Co Cl_2 6H_2O$	238
Copper, bromide	$Cu Br_2$	223.5
— chloride	$Cu Cl_2 2H_2O$	170.5
— nitrate	$Cu (NO_3)_2 6H_2O$	357.5
— sulphate	$Cu SO_4 5H_2O$	249.5
Cyanine	$C_{29} H_{35} N_2 I$	544
Dextrine	$(C_6 H_{10} O_5)_x$	—
Diamidophenol	$C_6 H_3 OH (NH_2)_2$	124
Eosine	Na or K Salt of	—
Erythrosine	$C_6 H_4 (CO)_2 O (C_6 H OH X^*)_2$..	—
Ether	$C_4 H_{10} O$	74
Ferrous and ferric salts (see Iron)		
Formaline	40% sol. of CH_2O	—
Glycerine	$C_3 H_5 (OH)_3$	92
Glycin†	$C_6 H_4 OH NHCH_2 COOH$..	167
Gold, chloride yellow	$H Au Cl_4 4H_2O$	412
— — brown	$H Au Cl_4$	340
— — potassium	$K Au Cl_4 2H_2O$	414
— — sodium	$Na Au Cl_4 2H_2O$	398
Hydrogen, peroxide	H_2O_2	34
Hydroquinone	$C_6 H_4 (OH)_2$	110
Iodine	I	127
Iridious chloride	$Ir Cl_3$	299.5
— tetrachloride	$Ir Cl_4$	335
— potassium tetrachloride .	$K_2 Ir Cl_6$	484
— sodium tetrachloride ...	$Na_2 Ir Cl_6$	452
IRON.		
Ferric chloride (dry)	$Fe_2 Cl_6$	325
— chloride (lump)	$Fe_2 Cl_6 12H_2O$	541
— ammonia citrate, brown	$4 Fe C_6 H_5 O_7 3 (NH_4)_2 C_6 H_5 O_7 3Fe (OH)_3$	2030
— — — green	$5FeC_6H_5O_7 \cdot 2(NH_4)_2C_6H_5O_7N$ $H_4C_6H_7O_7 2H_2O$	1956
— oxalate	$Fe_2 (C_2 O_4)_3$	376

* The X in these formulæ may be bromine, iodine, or chlorine, which elements in other proportions constitute the various commercial dyes.

† Glycin is γ -oxyphenyl-glycin or γ -oxyphenyl-amido-acetic acid.

Name	Symbol	Mol. Weight
IRON.		
Ferric Ammonium oxalate ..	$(\text{NH}_4)_2 \text{Fe} (\text{C}_2 \text{O}_4)_3 \cdot 3\text{H}_2\text{O}$	428
— potassium oxalate	$\text{K}_2 \text{Fe} (\text{C}_2 \text{O}_4)_3 \cdot 3\text{H}_2\text{O}$	491
— sodium oxalate	$\text{Na}_6 \text{Fe} (\text{C}_2 \text{O}_4)_6 \cdot 11\text{H}_2\text{O}$	976
Ferrous, chloride (dry)	Fe Cl_2	127
— — (cryst.)	$\text{Fe Cl}_2 \cdot 4\text{H}_2\text{O}$	199
— oxalate	$\text{Fe C}_2 \text{O}_4 \cdot 2\text{H}_2\text{O}$	180
— potassium oxalate ...	$\text{K}_2 \text{Fe} (\text{C}_2 \text{O}_4)_2 \cdot \text{H}_2\text{O}$	328
— sulphate	$\text{Fe SO}_4 \cdot 7\text{H}_2\text{O}$	278
— ammonia sulphate ...	$\text{Fe} (\text{NH}_4)_2 (\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	392
Lead, acetate	$\text{Pb} (\text{C}_2 \text{H}_3 \text{O}_2)_2 \cdot 3\text{H}_2\text{O}$	379
— nitrate	$\text{Pb} (\text{NO}_3)_2$	331
Lithia, caustic	Li OH	24
Lithium, bromide	Li Br	87
— carbonate	$\text{Li}_2 \text{CO}_3$	74
— chloride	Li Cl (cryst. has $2\text{H}_2\text{O}$)	42.5
— iodide	Li I	134
Magnesium, chloride	Mg Cl_2	95
— sulphate	$\text{Mg SO}_4 \cdot 7\text{H}_2\text{O}$	246
Manganese, peroxide	Mn O_2	87
— sulphate	$\text{Mn SO}_4 \cdot 4\text{H}_2\text{O}$	225
Mercury,	Hg	200
— bichloride	Hg Cl_2	271
— iodide	Hg I_2	454
— potass. iodide (soluble)	$\text{HgI}_2 \cdot 2\text{KI}$	786
Metol*	$(\text{C}_6\text{H}_4\text{OHNHCH}_3\text{p})_2 \cdot \text{H}_2\text{SO}_4$	344
Palladious chloride	Pd Cl_2	177
— potassium chloride ..	$\text{K}_2 \text{Pd Cl}_4$	326
Para-amidophenol	$\text{C}_6 \text{H}_4 \text{NH}_2 \text{OH}$	109
Phenol (see Acid, carbolic)		
Platinum per (or bi)chloride ...	$\text{H}_2 \text{Pt Cl}_6 \cdot 6\text{H}_2\text{O}$	516.4
Potassium, ammonium chromate .	$\text{K NH}_4 \text{Cr O}_4$	173
— bicarbonate	K H CO_3	100
— bichromate	$\text{K}_2 \text{Cr}_2 \text{O}_7$	294
— boro-tartrate	$\text{C}_2 \text{H}_2 (\text{OH})_2 (\text{CO}_2)_2 \text{BOK}$	214
— bromide	K Br	119
— carbonate (dry)	$\text{K}_2 \text{CO}_3$	138
— chlorate	K Cl O_3	122.5
— chloride	K Cl	74.5
— chloro-platinite	$\text{K}_2 \text{Pt Cl}_4$	413.4
— chromate	$\text{K}_2 \text{Cr O}_4$	194
— citrate	$\text{K}_3 \text{C}_6 \text{H}_5 \text{O}_7 \cdot \text{H}_2\text{O}$	342
— cyanide	K C N	65
— ferricyanide	$\text{K}_3 \text{Fe} (\text{CN})_6$	329
— ferrocyanide	$\text{K}_4 \text{Fe} (\text{CN})_6 \cdot 3\text{H}_2\text{O}$	422
— hydrate	K HO	56

* Metol is the sulphate of mono-methyl-para-amido-phenol.

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Name	Symbol	Mol. Weight
Potassium, iodide	K I	166
— metabisulphite	K ₂ S ₂ O ₅	222
— nitrate	K NO ₃	101
— nitrite	K NO ₂	85
— oxalate	K ₂ C ₂ O ₄ H ₂ O	184
— percarbonate	K ₂ C ₂ O ₈	198
— perchlorate	K Cl O ₄	138.5
— permanganate	K ₂ Mn ₂ O ₈	316
— persulphate	K ₂ S ₂ O ₈	270
— sulphate	K ₂ SO ₄	174
Sulphocyanide	K C N S	97
Pyrocatechin	C ₆ H ₄ (OH) ₂	110
Rochelle salt	K Na C ₄ H ₄ O ₆ 4H ₂ O	282
Schlippe's salt (sodium sulphanthionate)	Na ₃ Sb S ₄ 9H ₂ O	479
Silver, acetate	Ag C ₂ H ₃ O ₂	167
— ammonium nitrate	Ag NO ₃ +2NH ₃	204
— bromide	Ag Br	188
— carbonate	Ag ₂ CO ₃	276
— chloride	Ag Cl	143.5
— citrate	Ag ₃ C ₆ H ₅ O ₇	513
— fluoride	Ag F 4H ₂ O	199
— iodide	Ag I	235
— nitrate	Ag NO ₃	170
— nitrite	Ag NO ₂	154
— oxalate	Ag ₂ C ₂ O ₄	304
— oxide	Ag ₂ O	224
— phosphate	Ag ₃ PO ₄	419
— sulphate	Ag ₂ SO ₄	312
— sulphide	Ag ₂ S	248
— tartrate	Ag ₂ C ₄ H ₄ O ₈	363.4
Sodium, acetate	Na C ₂ H ₃ O ₂ 3H ₂ O	136
— — (fused)	Na C ₂ H ₃ O ₂	182
— bicarbonate	Na H CO ₃	84
— bichromate	Na ₂ Cr ₂ O ₇ 2H ₂ O	298
— bisulphite	Na H SO ₃	104
— borate	Na ₃ B ₄ O ₇ 10H ₂ O	382
— bromide	Na Br 2H ₂ O	139
— carbonate (dry)*	Na ₂ CO ₃	106
— carbonate (cryst.)	Na ₂ CO ₃ 10H ₂ O	286
— chloride	Na Cl	58.5
— chloro-platinite	Na ₃ Pt Cl ₆ 6H ₂ O	560.4
— citrate	Na ₃ C ₆ H ₅ O ₇ 5½H ₂ O	357
— fluoride	Na F	42

* In formulæ 10 parts anhydrous (= dry) soda carbonate can be used in place of 27 parts cryst. soda carbonate. 10 parts of cryst. equal 3¾ parts of the dry.

Name	Symbol	Mol. Weight
Sodium, hydrate (caustic)	Na OH	40
— hydrosulphite†	Na H SO ₂	88
— hyposulphite‡	Na ₂ S ₂ O ₃ 5H ₂ O	248
— iodide	Na I	150
— nitrate	Na NO ₃	85
— nitro-prusside	Na ₄ Fe ₂ (CN) ₁₀ (NO) ₂ 4H ₂ O	600
— oxalate	Na ₂ C ₂ O ₄	134
— phosphate	Na ₂ HPO ₄ 12H ₂ O	358
— tribasic phosphate	Na ₃ PO ₄ 12H ₂ O	380
— sulphate (cryst.)	Na ₂ SO ₄ 10H ₂ O	322
— sulphide	Na ₂ S 9H ₂ O	240
— sulphite (dry)§	Na ₂ SO ₃	126
— — (cryst.)	Na ₂ SO ₃ 7H ₂ O	252
— tungstate	Na ₁₀ W ₁₂ O ₄₁ 28H ₂ O	3598
Strontium, bromide	Sr Br ₂	247.5
— chloride (dry)	Sr Cl ₂	158.5
— — (cryst.)	Sr Cl ₂ 2H ₂ O	194.5
— iodide	Sr I ₂	341.5
— nitrate	Sr (NO ₃) ₂	211.5
Thiocarbamide	CS (NH ₂) ₂	76
Thiosinamine	CS (NH ₂) NH C ₃ H ₅	116
Thymol	CH ₃ C ₆ H ₃ OH C ₃ H ₇	150
Tin (Stannous) chloride	Sn Cl ₂ + 2H ₂ O	225
Uranium, acetate	UO ₂ (C ₂ H ₃ O ₂) ₂ 2H ₂ O	426
— chloride	UO ₂ Cl ₂	343
— nitrate	UO ₂ (NO ₃) ₂ 6H ₂ O	504
Zinc, sulphate	Zn SO ₄ 7H ₂ O	287

A TABLE OF ATOMIC WEIGHTS OF THE CHEMICAL ELEMENTS

Name	Symbol	Atomic Weight in Round Numbers	Accurate Atomic Weight
Aluminium	Al	27	27.1
Antimony	Sb	120	120.2
Argon	A	40	39.9
Arsenic	As	75	75.0
Barium	Ba	137	137.43
Beryllium	Be = Gl	9.1	9.1
Bismuth	Bi	208	208.0
Boron	B	11	11.00
Bromine	Br	80	79.96

† Called "hyposulphite" by chemists.

‡ Called "thiosulphate" by chemists.

§ In formulæ, 1-part of anhydrous (= dry) soda sulphite can be used in place of 2 parts cryst. soda sulphite and *vice versa*.

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Name	Symbol	Atomic Weight in Round Numbers	Accurate Atomic Weight
Cadmium	Cd	112	112.4
Cæsium	Cs	133	132.9
Calcium	Ca	40	40.1
Carbon	C	12	12.0
Cerium	Ce	140	140.25
Chlorine	Cl	35.5	35.451
Chromium	Cr	52	52.11
Cobalt	Co	59	59.00
Copper	Cu	63.5	63.60
Erbium	Er	166	166.0
Fluorine	F	19	19.0
Gadolinium	Gd	156	156.01
Gallium	Ga	70	70.0
Germanium	Ge	72.5	72.5
Gold	Au	197	197.2
Helium	He	4	4.0
Hydrogen	H	1	1.008
Indium	In	115	115.0
Iodine	I	127	126.97
Iridium	Ir	193	193.0
Iron	Fe	56	55.9
Lanthanum	La	139	138.9
Lead	Pb	207	206.92
Lithium	Li	7	7.03
Magnesium	Mg	24	24.36
Manganese	Mn	55	55.0
Mercury	Hg	200	200.0
Molybdenum	Mo	96	96.0
Neodymium	Nd	144	143.6
Nickel	Ni	59	58.70
Niobium	Nb = Cb	94	94.0
Nitrogen		14	14.04
Osmium	Os	191	191.0
Oxygen (Standard)	O	16	16.0
Palladium	Pd	106	106.5
Phosphorus	P	31	31.0
Platinum	Pt	193.4	194.8
Potassium	K	39	39.15
Praseodymium	Pr	141	140.5

Name	Symbol	Atomic Weight in Round Numbers	Accurate Atomic Weight
Radium	Ra		
Rhodium	Rh	103	103.0
Rubidium	Rb	85	85.5
Ruthenium	Ru	102	101.7
Samarium	Sm	150	150.3
Scandium	Sc	44	44.1
Selenium	Se	79	79.2
Silicon	Si	28	28.4
Silver	Ag	108	107.93
Sodium	Na	23	23.05
Strontium	Sr	87.5	87.6
Sulphur	S	32	32.06
Tantalum	Ta	183	183.0
Tellurium	Te	128	127.6
Terbium	Tb	160	160.0
Thallium	Tl	204	204.1
Thorium	Th	233	232.5
Thulium	Tu	171	171.0
Tin	Sn	118	119.0
Titanium	Ti	48	48.1
Tungsten	W	184	184.0
Uranium	U	240	238.5
Vanadium	V	51	51.4
Ytterbium	Yb	173	173.0
Yttrium	Yt	89	89.0
Zinc	Zn	65	65.4
Zirconium	Zr	91	90.6

Appendix

EASTMAN PLATES.—After June 30, 1924, the distribution of Seed, Standard and Stanley Plates will be discontinued by the Eastman Kodak Company. The new Eastman Plates listed in the left hand column can be used for the same purposes as those formerly supplied, which plates are listed opposite in the centre column. The approximate relative speeds are given at the right.

Eastman 40	Seed 30	100%
Eastman 36	Seed 26X	80%
Eastman Speedway	Seed Graflex	150%
Eastman Process	Seed Process	5%
Eastman 33	Seed 23	26%
Eastman Universal	{ Standard Extra Imperial	80%
	{ Stanley Regular	
Eastman Polychrome	Standard Polychrome	90%
Eastman Commercial	Stanley Commercial	30%
Eastman D C Ortho	{ Seed Non-Halation L Ortho	80%
	{ Standard Orthonon	
Eastman S C Ortho	Seed L Ortho	80%
Eastman Post Card	Standard Post Card	32%
Eastman Lantern	{ Standard Lantern Slide	3%
Slide	{ (Regular, Slow)	
(Regular, Slow)	{ Seed Lantern Slide	2%
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W. W. Panchromatic	Seed Panchromatic	

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